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STAFF APPRAISAL REPORT

KOREA

SECOND WATER SUPPLY PROJECT
(NAGDONG BARRAGE)

September 26, 1983

Urban and Water Supply Division
East Asia and Pacific Projects Department

CURRENCY EQUIVALENTS
(As of September 1, 1983)

Currency unit = Won (W)
Won 1.00 = US$0.00128
US$1.00 = W 780

FISCAL YEAR

January 1 to December 31

WEIGHTS AND MEASURES

meter (m)	=	3.28 feet
pyong	=	3.3 square meters (sq m)
kilometer (km)	=	0.62 miles
square kilometer (sq km)	=	0.39 square miles
hectare (ha)	=	10,000 square meters or 2.47 acres
cubic meter (cu m)	=	264 US gallons
cubic meters per second (cu m/s)	=	22.82 million US gallons per day
cubic meters per day (CMD)	=	264 US gallons per day
Gigawatt hour (GWh)	=	1 million kilowatt hours (kWh)
liter (l)	=	0.26 US gallons
liters per capita per day (lpcd)	=	0.26 US gallons per capita per day
milligrams per liter (mg/l)	=	parts per million (ppm)

PRINCIPAL ABBREVIATIONS AND ACRONYMS USED

ADB	=	Asian Development Bank
ADC	=	Agriculture Development Corporation
EMU	=	Environmental Management Unit
EPB	=	Economic Planning Board
ERP	=	Expert Review Panel
ERR	=	Economic Rate of Return
FAO	=	Food and Agricultural Organization
IMC	=	Interministerial Committee
ISWACO	=	Industrial Sites and Water Resources Development Corporation
KDB	=	Korea Development Bank
KEPCO	=	Korea Electric Power Company
MOC	=	Ministry of Construction
MOF	=	Ministry of Finance
MOHA	=	Ministry of Home Affairs
MOHSA	=	Ministry of Health and Social Affairs
OECF	=	Overseas Economic Cooperation Fund of Japan
OOE	=	Office of the Environment
ROK	=	Republic of Korea
UNDP	=	United Nations Development Programme
WB	=	Water Bureau

KOREA: SECOND WATER SUPPLY PROJECT

(NAGDONG BARRAGE)

STAFF APPRAISAL REPORT

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This report is based on the findings of an Appraisal mission consisting of Messrs. C. Fernandez (Financial Analyst) and E. Fernando (Engineer) who visited Korea in May 1983. Elisabeth Hellman assisted in preparing the report.

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I. THE WATER SUPPLY AND SANITATION SECTOR

Country Background

1.01 The Republic of Korea (ROK) is situated in the southern part of the Korean peninsula and occupies a land area of 98.9 thousand sq km. About two thirds of the land is mountainous and largely unsuitable for human settlement. There are ten major river basins in the country which account for 75% of the land area. The climate is characterized by dry and cold winters, warm summers and cyclical droughts.

1.02 Korea's population in 1981 was 38.7 million. Its population density of almost 400 persons/sq km is one of the highest in the world; it is also one of the most urbanized of the developing countries. The overall population growth rate decreased from 3% in 1960 to about 1.5% at present. The urban population in 50 cities (Si) and 137 towns (Eubs) with over 50,000 and 20,000 persons respectively, constituting 60% of the total, has been increasing by 5% p.a. between 1975 and 1980, or at about three times the overall growth rate. There are 1,253 small communities (Myeons) with populations between 10,000 and 20,000 and 62,328 smaller villages. By the end of the century the urban population is expected to level off at about 80% of a total population of 50 million. This rapid urbanization is creating problems of increasing population density, traffic congestion, sanitation and other environmental problems and has stretched all urban services, particularly those provided by the Government, like water supply. Government priority earlier focused on developing the industrial sector, leaving urban infrastructure and services relatively neglected. Starting in the 1970's, the government began to give increased priority to the delivery of social services, improving the water supply sector and related health conditions.

The Environment

1.03 Korea's accelerated industrial and urban growth has been responsible for a decline in the quality of the environment because of increasing water, soil and air pollution. Surface, groundwater and soil pollution is caused mainly by agricultural chemicals, improper collection and disposal of night soil, solid wastes and toxic industrial wastes and sludges, directly and through runoff. Fish kills have been reported in coastal waters off Ulsan, Masan and Jinhae. Air pollution standards for long-term exposure to sulphur dioxide (0.05 ppm versus 0.03 ppm in the US) were exceeded in Seoul in 1979 by more than 100% and in Busan by more than 16%.

1.04 Government programs are producing results. Waterborne diseases have declined steadily since 1971. The crude death rate went down from 13 to 7 per thousand persons between 1960-81, while life expectancy increased from

53 to 66 years in the same period. However, intestinal parasitic infections are still prevalent, particularly in areas where nightsoil is used as fertilizer.

Water Resources

1.05 The Ministry of Construction (MOC) has jurisdiction over the development and use of water resources throughout Korea. The Agriculture Development Corporation (ADC), a semi-autonomous agency under the Ministry of Agriculture and Fisheries, has authority to construct dams for irrigation and to reclaim land for agriculture. In 1980 the total volume of water supplied was estimated at 17.5 billion cu m with 14.2 billion cu m (73%) available from rivers, 1.4 billion cu m (18%) from groundwater and 3.3 billion cu m (19%) from storage reservoirs. Domestic consumption was 14%, industrial 4%, agricultural 64% and other uses 18%. Total volume of precipitation is estimated at 114 billion cu m per annum. Groundwater reserves are estimated at 232 billion cu m but may prove difficult to develop on a large scale. The supply of water is expected to increase from 17.5 to 29.7 billion cu m by 1991 with storage reservoirs providing 80% of the additional demand, or 44% of total supply.

1.06 The four largest river basins - Han, Nagdong, Geum and Yongsan - contain 66% of the land, and 70% of the industry and urban population of Korea. Most of the major cities and industries and the best agricultural land depend on these rivers for water. Water resources are becoming scarce; the annual surface water runoff per capita is only about 1,700 cu m or about 40% and 12% of run off per capita in Japan and the US, respectively. Furthermore, two thirds of the average annual precipitation of 1160 mm is concentrated in three months, July to September. Serious floods are frequent during these months, followed by cyclical droughts. Several multipurpose dams have been or are being constructed in the four main river basins to reduce flooding and to provide storage for municipal and industrial needs, agriculture and power generation (Annex 1). The cost for water resource conservation and development is increasing rapidly due to the shortage of suitable dam sites and increasing land compensation costs.

Sector Organization

1.07 There is no single agency in charge of overall planning, programming and financing of the water supply and sanitation sector. At the Central Government level four Ministries are directly involved in the sector in various ways. These are: the Ministry of Construction (MOC), the Ministry of Home Affairs (MOHA), the Ministry of Health and Social Affairs (MOHSA); and the Economic Planning Board (EPB) (see Chart 1).

1.08 MOC is responsible for planning, financing and constructing major works for water supply production and for water resources management (including collection of hydrological data, issuing licenses for abstraction of water and planning multipurpose dams) through, respectively, the Water

Works and Dam Development Divisions of the Water Resources Bureau. The Sewerage Division of the Urban Planning Bureau performs a similar function in respect to major sewerage works. MOC has five regional construction offices which are responsible for implementing and inspecting works in different provinces. The Industrial Sites and Water Resources Development Corporation (ISWACO), a semi-autonomous corporation under MOC, promotes and builds industrial sites and industrial water supply, constructs and operates multipurpose dams and regional water supply projects.

1.09 MOHA, through its Local Finance Division, under the Local Finance Bureau, is responsible for overseeing the management of city Water Bureaus (WBs), including the approval of bonds, loans, tariffs and the expansion of distribution and storage facilities. The WBs (Water Divisions in the smaller towns) are part of each city and the cities are under the provincial government. However, Seoul, the capital city comes directly under the Prime Minister Office while the other three "special cities" (Busan, Daegu and Incheon) are under MOHA's jurisdiction. The management, planning, design, construction and operation of water works in the municipalities is the responsibility of the WBs. They operate as independent entities; accounts, revenues, costs and budgets are separated from the general accounts of each city. WBs are subject to guidance and staff receive training from MOHA; new accounting guidelines for all WBs have been developed by MOHA and are satisfactory to the Bank.

1.10 MOHSA is responsible for the standards and quality control of drinking water and for establishing policy guidelines, providing funds and monitoring implementation for rural water and sanitation programs. Under a MOHSA program 28,000 simple piped rural water supply systems have been completed by 1980. This successful water supply program is expected to be completed by 1986. Each county (Gun) constructs these systems assisted by the provincial government and MOHSA.

1.11 The Office of Environment (OOE), created in 1980 under MOHSA, is responsible for environmental policies and pollution control (solid, liquid and air). It has six regional offices for monitoring, controlling and coordinating environmental projects. Under the Environmental Preservation Law, OOE also must approve development projects which have an important impact on the environment.

1.12 EPB, through its Price Policy Bureau, sets guidelines on tariffs. EPB also approves and allocates counterpart funds for MOC's projects which are financed by foreign loans. The Ministry of Finance (MOF), through its International Finance Bureau, coordinates foreign finance for development projects.

Service Levels

1.13 About 55% of Korea's population was served by piped water supply systems in 1980, compared with 17% in 1960 and 33% in 1970. The level of

service was better (83%) in the 50 larger cities with populations over 50,000 (including the capital city of Seoul with a population of 8.7 million) where high population densities and polluted aquifers leave no alternative to publicly supplied water.

1.14 The reliability of water supply is generally poor since the expansion of services has lagged behind the rapid urban growth. The fringe areas of many cities suffer from low pressures and water rationing. During 1981, the total volume of water produced by municipal and industrial (M&I) systems amounted to 4,500 million cu m, of which almost 90% was surface water, the remainder being groundwater. Water produced by M&I systems averages about 260 liters per capita per day (lpcd), with production in major cities such as Seoul, Busan and Incheon being of the order of 260-350 lpcd. However, one quarter to one half of the water produced is unaccounted-for, leakage being a major factor. Technical assistance and training in leak detection are included in the project (para. 3.03). Almost half of the water consumed is used by commercial, industrial and government consumers, with domestic usage being below 100 lpcd. The uncertain pressures and high leakage, together with the discharge of sewage effluents into street drains with consequent dangers of infiltration, make the water in the distribution systems of several cities unsafe. Except for the rural systems, treated water is chlorinated before distribution although optimum dosages are not always consistently maintained.

1.15 In a sample of cities with populations over 50,000, only 22% of the dwellings had flush toilets in 1979; the rest used night soil collection systems. Most of the waste water from septic tanks, domestic use and urban runoff is discharged untreated, into surface waters. Night soil is frequently used as a fertilizer after composting with rice husks in rural areas. This situation is now being improved. There are vault privies with night soil collection and treatment facilities in 40 large cities serving a population of 20.8 million. Master plans for sewerage and sewage treatment for Seoul and Busan have been prepared and construction started in 1982. Seoul has existing treatment plants (360,000 cu m per day [CMD]) capable of treating the sewage of one third of its population and would have almost three times this capacity by 1987. Busan has a plant treating night soil from about half of its population. Two additional sewage treatment plants and main sewers are scheduled for construction during 1984-87. In 1981, there were 104 night soil treatment plants in Korea; a project to construct another 66 plants, covering 102 small and medium towns (5,000 to 50,000 inhabitants) to treat 60% of the nightsoil is being prepared by the Asian Development Bank (ADB).

1.16 It is estimated that 42% of water pollution is due to municipal wastes and night soil, 45% to industrial wastes and 13% to agricultural runoff. There are about 16,000 industrial plants in the country generating pollutants, often toxic in nature, which require treatment before disposal. Important progress in pollution control has been achieved in recent years with the enactment of the Environmental Preservation Law (December 31, 1977), its Technical Regulations (July 1, 1978) and the establishment of the OOE in January 1980.

Sector Development

1.17 Sector investment (at 1983 prices) increased from $218 million in the Third Plan, to $530 million in the Fourth Plan (1977-81) and is forecasted at $1,442 million for the Fifth Plan (1982-86)./1 Government's policies for the sector in the Fifth Plan include preservation of water quality, replacement of obsolete equipment and pipelines, investment in sewerage and sewage treatment and expansion in capacity and coverage of water supply systems. Budgetary constraints may slow down implementation. The target for 1986 is to increase the overall percentage of population served by treated water from 55% to about 70% but in cities with more than 50,000 persons the percentage of population served by treated water would increase from 83% to 93%. Given the high rate of urban population growth, maintaining even the present coverage requires substantial investments.

1.18 Environmental pollution abatement is a feature of the Fifth Plan; the Master Plan for environmental protection of the Han River Basin (financed by ADB) has identified priority pollution control investments for the Metropolitan Seoul area. OOE, under Loan 2072-KO (First Water Supply Project), is undertaking satisfactory measures in the Nagdong River Basin: (a) a comprehensive Water Management Survey of the Nagdong and the other two major river basins is being conducted by OOE since 1981 and is scheduled for completion in 1984; (b) river water quality monitoring stations have been established, including eight in the Nagdong Basin; and (c) the industrial complexes of Gumi, Ulsan, and Changweon/Masan and the cities of Daegu, Gwangju, and Busan will have major sewerage and treatment facilities by 1986. Similar plans are underway for Incheon, Banweol, Yeochan, Daejeon and Jeongju. Furthermore, OOE will impose pollution charges on industries violating pollution standards and is establishing an Environmental Fund which will charge polluting industries and provide low interest loans for investments in pollution control. Government plans to increase the percentage of population served by sewage treatment plants from 6% in 1980 to 35% by 1991, and the sewage treatment capacity from 0.5 to 8 million CMD during the same period. Sewerage investments in the Fifth Plan are estimated at $1 billion in 1982 prices.

Sector Financing and Tariffs

1.19 The expansion of water production capacity, distribution and storage facilities and house connections are financed in part by loans which are budgeted by MOC and provided to the cities through the Korea Development Bank (KDB). These loans finance 40-70% of the production expansion components, or some 25% of total investments, and bear commercial interest

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/1 Of which $700 million are Central Government and the rest local government expenditures.

rates (currently 10%), with a repayment period of 15 years, and grace periods linked to construction schedules. The balance is financed by foreign loans, WBs' internal generation (15-35%), local city bonds (20-40%) currently at 8.5% interest and commercial loans. However, a reliable source of funds is not available. Since bonds and commercial loans are repayable within five years (compared with a 40-year useful life of assets and 3-5 year construction period), debt servicing payments are high even with refinancing. In the rural sector, the provincial government and MOHSA each finance one third of the investment costs with the remainder being financed by the villages.

1.20 Tariffs are set by the WBs, with the approval of MOHA, and in general cover the cost of operation, debt service and contribute to capital investments. The Price Policy Bureau of EPB provides guidelines on maximum tariff increases which reflect macroeconomic policies. Charges on industries or cities abstracting water directly from major rivers are collected by ISWACO to recover the cost of investments in dams and reservoirs. Tariffs for supply of bulk water for cities or industrial sites are determined by ISWACO with the approval of MOC and EPB. At present there are no Government financial performance targets for either ISWACO or in general for the WBS. Under this project such targets will be established for the Water and Dam divisions of ISWACO, and marginal pricing policies for the water available from the proposed barrage would be implemented (paras. 5.09 and 6.10). Sewerage is financed from city revenues and loans; separate sewerage tariffs are now being introduced in the major cities.

Manpower

1.21 There is a lack of basic information on availability of manpower in the water sector and on training needs as identified by the Sector Study./1 To overcome this, a Sector Manpower Survey, for which Terms of Reference have been discussed with MOC, is to be carried out under Loan 2072-KO. Training programs for the sector will be based on findings of this survey and further studies envisaged under ADB's Small Towns Water Supply Project. Proposals for operational training needs of the five cities financed under Loan 2072-KO have been formulated and are being reviewed. Generally the level of education and trained skills available in Korea is high, and equipment and facilities are well maintained and operated. Expertise is lacking in specific special skills required (high rate filter operation, leak detection, and computer technology), and training programs are expected to focus on these special needs. In the sanitation sector a UNDP funded project for development and training of manpower for environmental pollution control is being implemented by OOE since 1982. This project provides support (equipment, curricula development, foreign training advisors, and overseas training) to the National Environmental Protection Institute for comprehensive basic and

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/1 WHO/IBRD Cooperative Program - Republic of Korea; Sector Study on Water Supply and Sanitation (1981).

special training programs for personnel in central and local government and industry. These programs will train 4,700 persons in various fields of environmental pollution control between 1983 and 1985.

Issues and Constraints

1.22 The fragmentation of responsibilities amongst four ministries has resulted in a lack of coordination in sector planning. Rivalry between the two principal ministries responsible for the sector, MOC and MOHA, at times causes each to pursue its own priorities without reference to overall sector objectives. Some of the responsibilities of the sector agencies are highly complementary, requiring closer coordination and cooperation, (e.g. MOHA should strengthen the WBs' finances and operation in anticipation of facilities built by MOC, and approve bonds and tariffs required to finance investments). Under the First Water Supply Project, agreement was reached with the Government to establish an Interministerial Committee (IMC). This Committee has been established under Terms of Reference agreed to by the various ministries and the Bank. The IMC will study these coordination problems and make recommendations to delineate more precisely the respective responsibilities. These studies have been delayed beyond the original target of June 1983. A sector study was completed by consultants during the preparation of the recently approved ADB's Small Towns Water Supply Project. This study, after Bank comments, would be reviewed by the IMC and final recommendations to improve sector coordination would be completed by December 31, 1984.

1.23 Korean consultants are technically competent to design most water supply, distribution and sewerage systems. However, local project preparation is generally weak in economic and financial analysis. External assistance is still required in these areas and for the design of large dams, pollution control, treatment plants and optimal design technology. Technical assistance would be concentrated in these areas.

1.24 While local water facilities are well operated technically, the WBs' financial and management practices require improvement. Deficiencies include a high level of unaccounted for water, the nonuse of double entry accounting, manual billing, weak management information systems, and insufficient staff. The project addresses these problems through two national components, which would introduce in WBs measures for leakage detection, and institutional improvements in accounting and financial management (using microcomputer-based software and hardware). This would reinforce MOHA's efforts to implement improved financial practices in all WBs.

1.25 At present Korea does not have a well-developed system for mobilizing and allocating resources for the sector. Although water supply projects require lengthy construction periods and provide service for many years, the main stable resources available are short-term borrowings and internal revenues. This results in investment lagging behind demand and debt service higher than if long-term financing were available. As one

option for providing long-term funds for the sector, the Bank is discussing with the Government the establishment of an urban fund to finance, inter alia, water supply investments.

Bank Objectives and Lending in the Sector

1.26 Bank objectives in the sector are: (a) to promote adequate, reliable and affordable water and sanitation services; (b) to help strengthen the institutions and improve coordination within the sector, particularly in the area of investment planning; and (c) to develop a solid financial basis for the sector, including improved cost recovery through better pricing policies and access to long-term resources. In line with Government's own shifting priorities, the Bank has been assisting Korea to improve the functioning and efficiency of urban areas. A critical urban service in a densely populated country such as Korea is the provision of adequate and reliable water for residential and industrial use. Bank support for all urban services, including water supply, is expected to improve the quality of life for all Koreans, as well as eliminate this possible bottleneck to continued economic growth. The Bank is in close contact with other international agencies (ADB, OECF and UNDP) who are actively working in the sector.

1.27 The Bank has helped finance several projects with sectoral components: (a) the Chungju Multipurpose Project, approved in 1979, (Loan 1666-KO) where about one third of the benefits are for water supply; (b) the Rural Infractructure I and II Projects (Loans 1216-KO and 1530-KO) which financed 11,400 rural piped water supply systems; (c) the Second Regional Project in Gwangju (Loan 1758-KO) included water supply for provincial cities and industrial sites; and (d) the Kyongju Tourism Project (Loan 953-KO) included water supply and sewage treatment facilities. The ongoing projects are being implemented satisfactorily. For Loan 1216-KO OED has prepared an Audit Report which notes that almost twice the originally planned number of village water systems had been satisfactorily implemented without delay and for Loan 953-KO the Completion Report stated that the water supply component had been implemented satisfactorily but that slow growth in tourism had resulted in excess capacity and poorer than anticipated financial performance for the water supply component. The proposed Jeonju Regional Project (appraised in April 1983) would include water supply and distribution facilities for Jeonju City. The First Water Supply Project (Loan 2072-KO), approved in 1982, is expanding the water supply in five cities (Daegu, Gwangju, Masan, Changweon and Jinhae). The hiring of consultants for supervision resulted in some initial delays, but the project is now being executed smoothly, and compliance with covenants is generally satisfactory. However, reduced Government expenditures in 1983 have resulted in budget deficiencies in some of the project cities. These financial shortfalls were discussed with the Bank and at a recent meeting of the IMC satisfactory financial plans were agreed upon for 1983 and 1984, including government loans and grants, bonds and additional tariff increases before end-1983.

II. POPULATION AND WATER DEMAND IN THE NAGDONG RIVER BASIN

Location

2.01 The Nagdong region (32,100 sq km, Map I) covers one third of the total area (98,900 sq km) of Korea, includes the provinces of Gyeongbuk and Gyeongnam, and contains one third of the population of the country. The region produces 30% of the agricultural and 40% of the industrial output. The bulk of this comes from the Nagdong River Basin (23,600 km sq). This basin is experiencing intense development, has a population of 8.5 million and comprises 70 municipalities, including 14 cities in addition to Busan and Daegu, the second and third largest cities in Korea.

Water Shortage Problem

2.02 The rainy season, in which about two thirds of the rainfall occurs, (July to September), is capricious and shows large variances from year to year. The geomorphological features of the basin, which has a high percentage (76%) of mountainous land with slopes steeper than 20%, promote quick runoff. Consequently river discharges vary considerably; from 30 cu m/s or less to more than 10,000 cu m/s. Appropriate places for the development of storage reservoirs are scarce, since the river widens downstream of Andong. The Andong Dam (financed by ADB) has been in operation since 1976 and is the main water conservation structure in the basin. Two other dams on tributaries, the Namgang and Yeongcheon Dams, are only important for flood control and local water conservation.

2.03 The Andong Dam, with a storage capacity of 926 million cu m, is situated 340 km from the river mouth. It takes about 12 days for water released from Andong to reach Busan. During the dry cold season (January-February) and periods of low flow and peak agricultural demand, substantial portions of the reservoir releases do not reach the delta area. Thirty-seven municipalities (12 cities and 25 towns) have or are constructing water supply facilities depending on the Nagdong river or its tributaries. Water supplies are presently curtailed, and any further water extraction would only exacerbate the problems of the downstream users during the critical period of January to June.

2.04 The increasing demand on the river, and the resulting decreased flow of fresh water in the delta, has resulted in exponentially increasing salinity of water at the intakes for Busan, Ulsan/Onsan and the Gimhae agriculture polder area. Korea's water quality standards specify a maximum salinity for potable water of 150 ppm (as compared with 250 ppm in most developed countries). However, salinities in excess of 2,000-2,500 ppm have frequently been reported since 1975 at the Busan intake, forcing Busan and Ulsan to stop pumping for hundreds of hours (Annex 10, para. 1). Salinity intrusion even reaches Samrangjin, located 44 km upstream from the river mouth.

2.05 The Gimhae polder area, the largest area of flat land in the basin (15,000 ha), constitutes 30% of the total irrigated paddy area along the main stream. This fertile land is gradually being damaged due to irrigation with water with salinity levels well above those registered in Busan. Release of water from Andong can no longer alleviate this problem. The situation would worsen dramatically when the new water supply projects under construction in Busan, Changweon, Jinhae, Daegu, Gumi, Masan, etc., enter into operation by 1985/86. The proposed barrage at the river mouth is necessary to reliably ensure saline free water at the main intakes for the Gimhae polder, Busan and Ulsan/Onsan. This would make available the Andong water (presently wasted to sea in unsuccessful attempts to prevent salt water intrusion) to meet increasing water demands of all the cities dependent on river water, particularly Busan, Ulsan/Onsan, and Gumi and the four cities under the First Water Supply Project (Daegu, Masan, Changweon and Jinhae). Failure to resolve this problem will cause serious damage to the local and national economy and adversely affect some 11 million people by the year 1992.

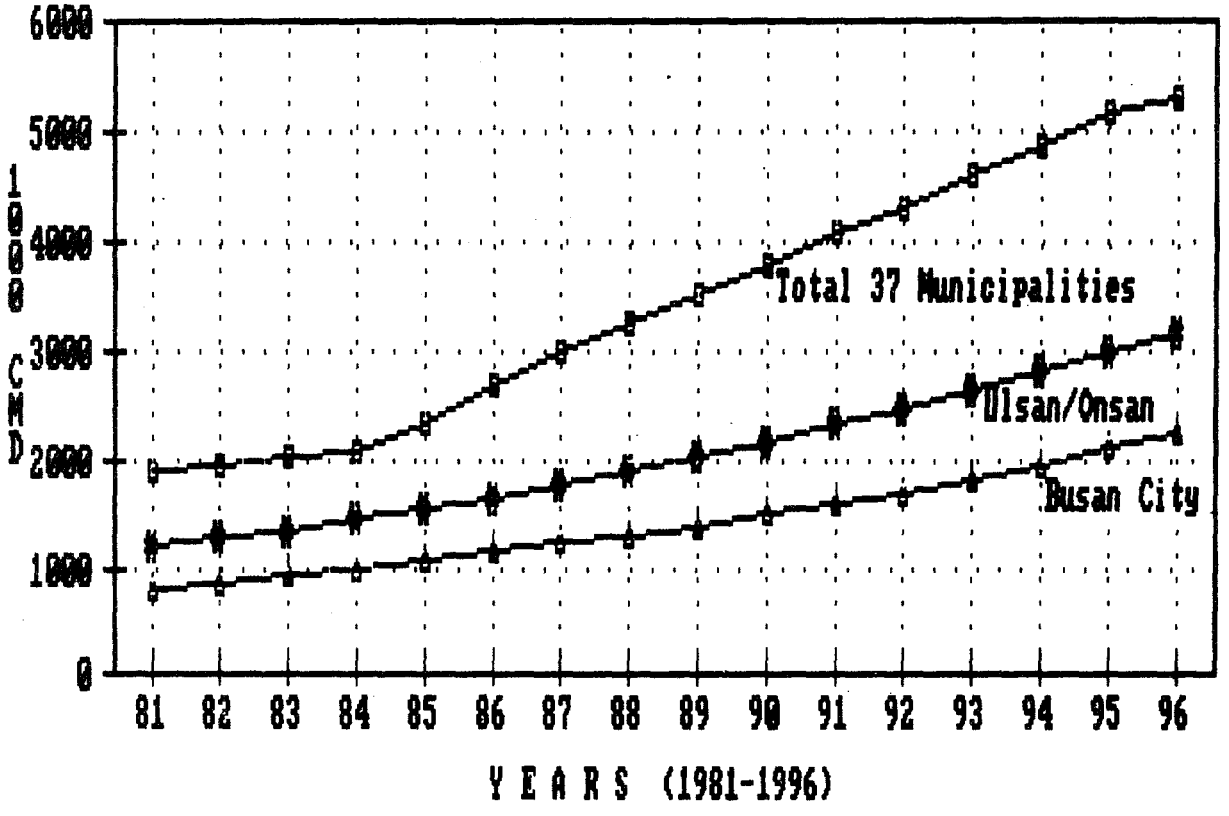
Population Served and Water Demand

2.06 The 37 municipalities depending on the Nagdong River or its tributaries for water supply are experiencing rapid rates of population growth, resulting from successful industrialization and rapid urbanization. MOC has made population forecasts for these municipalities up to the year 2001 (limited to 1991 for some towns). It has also set targets for population coverage, which averaged 83% in 1981 (varying from 30% to 89%) and is estimated to increase to 93% by 1991 as a result of projects under construction or scheduled during this period. MOC's population projections were reviewed by the Bank (Annex 3, Tables 1 and 2). The main difference between MOC projections and projections in Annex 3 is for Busan. MOC forecasts a population growth of 2.6% p.a. between 1981-91 for Busan. However, since annual data for the last 20 years show a steady population growth of 5.3% p.a., the projections in Annex 3 assume a more gradual decline in the rate of growth, averaging 4.7% p.a. for that period and 2.6% between 1991-2001.

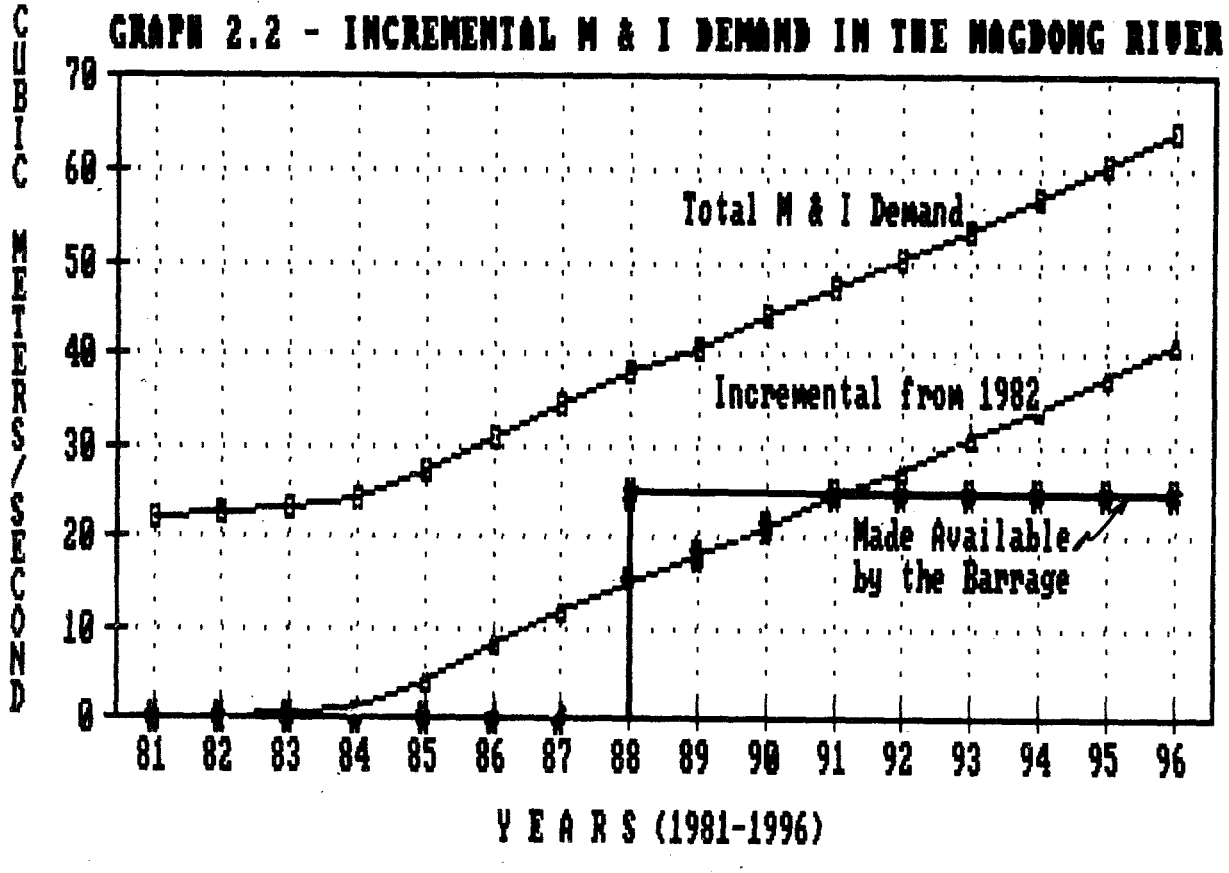
2.07 The projection of water demand is based on the population and levels of service explained above and the estimated per capita water production. As a result of the intense industrialization in this area (which has many new industrial cities like Changweon and Gumi), and the rapid increase in the population's income (growing at 6.9% p.a. during the last 20 years), the average per capita demand, including water losses, is assumed to increase from 225 to 395 lcpd during the next 20 years. This includes high industrial and commercial demand. The resulting demand (Annex 3) is generally lower, but of the same order of magnitude as the water demand estimated in other studies (UNDP FAO 1971; HAPCHEON, 1974; ISWACO, 1974; NEDECO, 1976; JICA, 1980, and NEDECO, 1983), and confirms the magnitude of the water requirement in the Nagdong Basin.

2.08 Agricultural water demand is related to the area under rice cultivation. The demand projection for agricultural water was made by ISWACO and

GRAPH 2.1 - MUNICIPAL AND INDUSTRIAL WATER DEMAND IN THE NAKDONG



GRAPH 2.2 - INCREMENTAL M & I DEMAND IN THE NAKDONG RIVER



a/ Source: Appraisal estimates, see Annex 3.

the project consultants (NEDECO/1), and assumes that the expansion of cultivated area will be very slow and will end before the year 2000. Both analyses assume that water use for agriculture will increase only some 140 million cu m per year until 1991. Since its coincidence with the low river flow months is only during a short period (May to June), this incremental demand has not been included thus making the overall demand estimates somewhat conservative.

2.09 The total water demand for municipal and industrial use is shown in Annex 3. The demand until 1986 is suppressed, partly because of insufficient water treatment and distribution facilities (Graph 2.1, and Annex 3). The water demand would increase 30% between 1983-86, when projects under construction financed by the First Water Supply project, as well as similar projects in Busan and other cities, would be completed. The total water demand in million cubic meters per day (CMD) is expected to increase from 1.9 in 1981 to 4.1 in 1991 and 6.8 in the year 2001. The main water users are Busan, Ulsan/Onsan and Daegu, which represent 81% of the total municipal and industrial demand. Busan has already started the construction of additional facilities for 0.5 million CMD (para. 3.04) and is planning to double its present capacity (from 0.9 to 2 million CMD) by 1990. The incremental water demand (Graph 2.2) shows that the water made available by the proposed barrage (about 25 cu m/s) would be fully used within the next eight years, and other sources of water (Hapcheon Dam) will be needed thereafter.

III. THE PROJECT

Project Origin

3.01 The need for a barrage at the Nagdong River mouth has been recognized since 1966. The project is based on studies undertaken since 1966: the Nagdong River Basin Preinvestment Study (UNDP/FAO, November 1966-March 1972), the Nagdong Basin Study (MOC, March 1973), and the Nagdong River Basin Development Project Feasibility Study (Nippon Koei, 1976). The Nagdong Delta Study (UNDP/FAO, 1974-1977) identified the estuary barrage as the next most economical investment project to increase available water resources in the Nagdong River. A feasibility study made by NEDECO in 1976 confirmed that the barrage is the least-cost solution to avoid salinity problems and to make available some 25 of the 40-50 cu m/s of water presently used to repel salinity and wasted to sea. Detailed design (by NEDECO) was financed under the Chungju Multipurpose Project (Loan 1666-KO), and carried out during 1980-83. The Interim (1981) and Final (1983) Reports are in the Project file. The overall design has been reviewed by an Expert Review Panel (ERP) established by ISWACO in consultation with the Bank. Agreement has been reached between the ERP, ISWACO, NEDECO and the Bank on all aspects of design. The specifications, contract documents and drawings have been modified accordingly. A project identification mission visited Korea in December 1982, the preappraisal was in February and the appraisal in May 1983. The project is based on final designs prepared by NEDECO.

/1 A Dutch Consultancy Engineering Consortium with extensive experience in drainage, land reclamation and coastal works.

Project Objectives

3.02 The objectives of the project are to:

(a) eliminate problems of water salinity at the water intakes for Busan, Ulsan/Onsan and the Gimhae agricultural area;

(b) make available to Busan and another 12 cities (Si) and 24 towns (Eubs) as well as to industrial zones, about 25 cu m/s (2.2 million CMD) of water presently released from upstream dams to prevent seawater intrusion into the Nagdong river;

(c) transfer technology in the area of leak detection and control, and implement such programs in about 15 cities where unaccounted-for-water exceeds 30%;

(d) establish improved accounting and management information systems, including micro-computer software and hardware, which would be implemented and tested initially in about 15 WBs, and extended to other WBs;

(e) implement sound financial and water pricing policies in ISWACO; and

(f) protect the Nagdong's estuarine environment and develop ISWACO's environmental management expertise.

Project Description

3.03 The proposed project includes three components (Annex 4):

(a) The Nagdong Barrage. The barrage is located at the Nagdong River mouth at Hadandong (Map 2). The site is accessible by road from Busan, which has good road, rail, air and port facilities. The 510 m long concrete barrage, retaining a 5 m water head in the reservoir, would control the left branch of the Nagdong River from Hadandong in Busan to the delta island of Elsukdo and is flanked on the west by a 1,200 m long dike across Elsukdo and a 700 m long closure dam across the right river branch. These provide an additional access from Busan to the west (Gimhae Airport, Masan/Jinhae coastal road and Seoul/Busan Expressway). The barrage includes its appurtenant works, the dikes, dredging, the land reclamation of 190 ha, a discharge sluice, a navigation lock, fish passes, a four-lane road, and service and operation facilities. The project also provides for the systematic monitoring of the estuarine environment, quantitative and qualitative ecological impact studies and the preparation and implementation of an environmental protection program by ISWACO (para. 3.15 and Annex 2); laboratory equipment for these studies and microcomputer hardware for environmental and financial management are also included;

(b) Leak Detection Program. This program is designed to reduce the large wastage of water, decrease the associated expenses in chemicals and energy, and lessen the magnitude of future investments required to expand water supply capacity. Appropriate methodologies will be designed and implemented to detect and correct water leakage in about 15 cities on a pilot basis. Experience gained will allow replication nationwide. Equipment to detect leaks will be acquired and the staff of the cities' WBs will be trained in this technology which is practically new to Korea; and

(c) Institutional Development Program. This program comprises the acquisition of microcomputer hardware as well as the design, preparation, testing and dissemination of microcomputer software for WBs throughout Korea. By developing common programs to handle billing, general accounting, payroll, inventory management and other functions, this component would assist in strengthening the accounting, financial and managerial capabilities of WBs. Initially the system will be designed for and tested in about 15 cities but would be extended later to all WBs in Korea.

Complementary Works

3.04 Busan is the largest port and the second largest city in Korea, with a population of 3.4 million. Busan has plans to use about half the water made available by the barrage, be relieved of water rationing and salinity problems, and have improved road access to the west, as well as 190 ha of reclaimed land for industrial and residential use. During the next few years, Busan will carry out a major water and sewerage works expansion program to be partly financed by the Japanese Overseas Economic Cooperation Fund (OECF) and commercial loans. Busan has started implementing a 500,000 CMD extension to its water supply and distribution system. This program includes new intake and raw water pumping mains, a treatment plant, main transmission and booster pumping stations, secondary distribution and leakage control programs and would increase the percentage of population connected to water supply from 90% to 95% during this period. Busan is also planning to construct the Jang Lim Sewerage scheme comprising main interceptor sewer and lift stations. These sewerage works are necessary to divert industrial and domestic wastes, particularly from the Sasang industrial area (presently being discharged untreated into the river), to downstream of the barrage. This will remove any danger of pollution affecting the water supply intakes after barrage construction. Busan is also planning to carry out minor modifications necessary to existing storm water pumping stations serving the diked areas adjacent to the barrage. Busan's complementary works were reviewed by the Bank. The total cost is $130 million and the financing plan, including $25 million OECF financing for water supply, is satisfactory (Annex 12). These works are an important complement for the timely achievement of project objectives and would be implemented by Busan City Water and Construction

Table 3.1: TOTAL PROJECT COST

	Local	For-eign	Total	Local	For-eign	Total	% of total	% for-eign exch.
	(W billion)			(US$ million)				
Nagdong barrage	54,444	41,496	95,940	69.8	53.2	123.0	62.9	43.3
Leak detection program	1,716	2,652	4,368	2.2	3.4	5.6	2.9	60.7
Institutional development	156	624	780	0.2	0.8	1.0	0.5	80.0
Base cost	56,316	44,772	101,088	72.2	57.4	129.6	66.3	44.3
Physical contingencies	9,906	7,722	17,628	12.7	9.9	22.6	11.5	43.8
Price contingencies	9,126	8,580	17,706	11.7	11.0	22.7	11.6	48.5
Total Project Cost	75,348	61,074	136,422	96.6	78.3	174.9	89.4	44.8
Interest during construction	1,560	14,508	16,068	2.0	18.6	20.6	10.5	90.3
Front-end fee	0	156	156	0.0	0.2	0.2	0.1	100.0
Total To Be Financed	76,908	75,738	152,646	98.6	97.1	195.7	100.0	49.6

Bureaus supported by local consultants. Assurances were obtained from Government that these works will be completed by December 31, 1987. A detailed description of these water and sewerage works is included in Annex 12. Water supply expansion works are being built satisfactorily by other main cities (Daegu, Ulsan/Onsan, Masan, Changweon, etc.), and are planned by MOC for the smaller towns.

Construction Schedule

3.05 The project will be implemented between October 1983-June 1988. The project is in an advanced stage of preparation, and bids were received from prequalified contractors in accordance with Bank guidelines. Construction, supply and installation of all works for the barrage were included in a single contract. This is expected to improve coordination and reduce the execution time. It was also necessary because of the limited working space available within the dewatered building pit and the interdependent nature of design of the various components. River diversion is not a problem since the closure dam is scheduled for construction only after barrage completion. Advantage will be taken of the 1983/84 dry season to construct the main coffer dams for the building pit and the 1987/88 dry season for the closure dam. The two national components are scheduled for execution during 1984-86. Chart 3 shows the project construction schedule.

Project Cost

3.06 The total cost of the project, including physical and price contingencies, is estimated at US$174.9 million, of which $78.3 million or about 45% would be the foreign exchange component (Table 3.1). Taxes and duties are estimated at US$8 million equivalent. A cost summary for the Nagdong Barrage component is shown in Table 3.2 and detailed estimates in Annex 5. The total financing needed, including interest during construction and the front-end fee, is $195.7 million./1

3.07 Cost estimates are based on detailed engineering and the contract award. The base costs are expressed in September 1983 prices. Physical contingencies have been estimated at 17%. Price contingencies for foreign costs were estimated at 8% for 1983, 7.5% for 1984, 7% for 1985 and 6% p.a. thereafter. Local price contingencies assume that domestic inflation would be 5% in 1983 and thereafter would be equal to the increase in foreign costs. Price increases over the project period are equal to $22.7 million or 15% of base cost plus physical contingencies. The consultant

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/1 ISWACO's practice is to capitalize the interest during construction. This has been calculated on the basis of the Bank loan, plus one short-term loan (four year terms, 10% interest) of W 8.4 billion from commercial banks.

TABLE 3.2 NAGDONG BARRAGE- PROJECT COST SUMMARY.

WORKS	---TOTAL IN MILLION WON			------TOTAL IN MILLION US$---			Z	Z
	LOCAL	FOREIGN	TOTAL	LOCAL	FOREIGN	TOTAL	OF TOTAL	FOREIGN
PREPARATORY WORKS	2130	1316	3446	2.73	1.69	4.42	2.64	38.20
TOTAL EARTH WORKS	10670	17279	27949	13.68	22.15	35.83	14.82	66.36
BARRAGE	7728	11747	19475	9.91	15.06	24.97	14.93	60.32
APPURTENANT WORKS	2884	4414	7298	3.70	5.66	9.36	5.60	60.48
ELECTRIC WORKS	428	496	924	0.55	0.64	1.18	0.71	53.65
MECHANICAL WORKS	1152	3085	4237	1.48	3.96	5.43	3.25	72.82
CUSTOM DUTIES & TAXES	6049	0	6049	7.76	0.00	7.76	4.64	0.00
LAND AND COMPENSATIONS	15531	0	15531	19.91	0.00	19.91	11.91	0.00
PROJECT MANAGEMENT	7902	3062	10964	10.13	3.93	14.06	8.41	27.93
MICROCOMPUTER HARD. SOFWARE	0	76	75	0.00	0.10	0.10	0.06	100.00
BASE COST (SEP 1983 PRICES)	54474	41475	95948	69.84	53.17	123.01	73.57	43.23
PHYSICAL CONTINGENCIES	9682	7372	17054	12.41	9.45	21.86	13.08	43.23
TOTAL CONSTANT PRICE	64156	48847	113002	82.25	62.62	144.87	86.65	43.23
PRICE CONTINGENCIES	8927	8343	17270	11.44	10.70	22.14	13.24	48.31
TOTAL COST	73083	57190	130272	93.70	73.32	167.02	99.89	43.90
BANK FRONT-END FEE		140	140		0.18	0.18	0.11	100.00
TOTAL FINANCING REQUIRED	73083	57330	130413	93.70	73.50	167.20	100.00	43.96

TABLE 3.3 - NAGDONG BARRAGE - FINANCING PLAN

	TOTAL MILLION WON	Z OF TOTAL	TOTAL $ MILLION	MILLION US $ 4/1983	1984	1985	1986	1987	2/1988
PROJECT COST	130272	89.31	167.02	10.45	37.50	41.84	44.30	28.78	4.14
INTEREST DURING CONSTRUCTION:									
IBRD LOAN	13989	9.59	17.93	0.27	1.42	2.49	4.09	5.99	3.68
OTHERS LOANS	1605	1.10	2.06	0.00	0.23	0.72	0.80	0.30	0.00
TOTAL TO BE FINANCED	145866	100.00	187.01	10.73	39.15	45.05	49.20	35.07	7.82
FINANCED BY:									
IBRD LOAN	57330	39.30	73.50	5.18	8.41	14.07	19.62	19.31	6.91
SALES OF RECLAIMED LAND	36492	25.02	46.79	0.00	0.00	0.00	25.18	20.66	0.94
EQUITY CONTRIBUTIONS	31200	21.39	40.00	0.00	18.00	18.00	4.00	0.00	0.00
ISWACO'S INTERNAL CASH GENERATION	20844	14.29	26.72	5.55	8.00	7.00	4.00	2.18	0.00
SHORT TERM LOAN: DISBURSEMENTS (+)	8357	5.73	10.71	0.00	4.74	5.98	0.00	0.00	0.00
AMORTIZATION (-)	-8357	-5.73	-10.71	0.00	0.00	0.00	-3.60	-7.08	-0.03
TOTAL FINANCING	145866	100.00	187.01	10.73	39.15	45.05	49.20	35.07	7.82

cost for the supervision of the barrage and environmental management support to ISWACO is estimated at $5 million, and consultant cost for leak detection and institutional development is estimated at $4.3 million. The average man-month cost (including salary, fees, international travel and subsistence) is $10,500, the average local and expatriate man-month costs are $6,000 (320 man-months) and $13,500 (550 man-months), respectively.

3.08 About 750 families living in the barrage area would be required to relocate, and 310 ha of low lying agricultural land would be acquired by ISWACO. In addition, fishermen will be compensated for damages during the construction period. The total cost of land and other forms of compensation are estimated at US$20 million in 1983 prices. Payments for land would average US$25,000/ha for rice land and US$16,000/ha for cultivated upland. All families, rural and urban, would receive removal and subsistence payments. The Government's policy is to promptly pay fair prices for land and property, compensation, removal expenses and subsistence during relocation. Land acquisition, relocation and compensation plans are being undertaken satisfactorily by a joint committee representing Busan City, MOC and ISWACO. ISWACO and the Government have satisfactorily executed many similar programs. Agreement has been reached with the Government that the compensation and relocation programs would be periodically reviewed by the Bank and the Government.

Financing Plan

3.09 Details of the Nagdong barrage financing plan, and annual Government contributions are shown in Table 3.3. The overall project financing plan is shown in Table 3.4. The proposed Bank loan of $78.5 million, including the capitalized front-end fee of $0.2 million, would finance the foreign exchange component of the project (47% of total project costs excluding taxes), or about 40.1% of the gross cost of $195.7 million, including interest during construction ($20.8 million). Interest during construction is based on the Bank's loan interest and front-end fee, and a short-term commercial loan of W 8.4 million at 10% interest, repayable before project completion. ISWACO would contribute $26.7 million (13.6% of gross cost), government equity $40.0 million (20.5%), and cities' internal generation $3.7 million (1.9%). Part of the land reclaimed during 1984/85 would be sold by ISWACO between 1986-88 to finance $46.8 million or 23.9% of the gross cost of the project. The financing plan was reviewed during loan negotiations, and government contributions of W 31 billion during the period 1984-86 were confirmed, including W 14 billion in 1984. Given the long time required to build the project and start collecting revenues, ISWACO requested a longer grace period (4.5 rather than 3 years) and shorter maturity (12 years rather than 15) for the proposed Bank loan. These terms are recommended. The Government would relend the Bank loan to ISWACO and to the project cities through MOHA (para. 4.01).

Table 3.4: PROJECT FINANCING PLAN
(Million $)

	Local	Foreign	Total	%
A. ISWACO				
IBRD		73.5	73.5	37.6
ISWACO's internal generation	26.7		26.7	13.6
Sales of reclaimed land	46.8		46.8	23.9
Equity contributions	22.2	17.8	40.0	20.5
	95.7	91.3	187.0	95.6
B. National components				
IBRD		5.0	5.0	2.5
Cities' internal generation	2.9	0.8	3.7	1.9
	2.9	5.8	8.7	4.4
Total	98.6	97.1	195.7	100.0

Project Implementation

3.10 ISWACO will be responsible for the implementation of the barrage component. Responsibility for engineering and procurement would rest with ISWACO headquarters at Daejeon, while construction supervision would be under a project office to be set up by ISWACO at Busan (para. 3.12). ISWACO's Director of Water Resources would serve as Project Director reporting directly to the President of ISWACO. ISWACO staff would be responsible for the project management with the support of engineering consultants. The staff assigned to the project would be organized in three construction supervision units, one quality control, one administrative, land acquisition and compensation and one environmental management unit. MOHA's Local Finance Division and the beneficiary cities (Annex 4) will implement the national programs for leak detection and institutional development. MOHA will hire consultants, individuals as well as joint ventures between local and foreign consultants, to design, prepare and implement detailed work programs and work with city WBs to train their staff. The consultants will also assist MOHA in monitoring progress and evaluating results. Responsibility for procurement of equipment and hiring of consultants would rest with MOHA's Local Finance Division. Detailed implementation plans are described in Annex 4.

Consulting Services

3.11 Consulting services for detailed engineering were financed from Loan 1666-KO (Chungju Multipurpose Project). The supervision of construction and environmental management would be financed under the project. About 350 man-months of foreign assistance would be needed. Engineering consultants (NEDECO), whose terms and conditions of employment by ISWACO are satisfactory, are assisting in the preparation of contract documents,

prequalification of bidders and the evaluation of bids and the contract award. NEDECO has also been hired for: (a) supervision of civil works construction, inspection of equipment fabrication, and supervision of equipment installation and performance tests; (b) review and certification of contract payments; (c) assistance in establishing and managing an environmental management unit; (d) preparation of monthly and annual progress reports; and (e) assistance in the initial operation of the project and in establishing operation and maintenance procedures. About 200 man-months of foreign consultants, and about 320 man-months of local consultants, would be needed for the leak detection and institutional improvement programs. These consultants will be hired by MOHA in accordance with Bank guidelines.

3.12 ISWACO will assign staff to work closely with the consultants in all aspects of project implementation, and will provide the majority of the supervision field staff. ISWACO's proposal to establish a project construction office at Busan with a staff of 90 (already on ISWACO's payroll) is satisfactory. The Expert Review Panel will be convened as necessary during execution to advise management on any special technical problems encountered. Other specialists may be hired if necessary. The panel will meet again soon after commencement of work.

Environmental Impact

3.13 The Nagdong estuary is a wintering and stopping place for migratory birds from the Arctic region during the winter months. The estuarine ecosystem of the area is characterized by tidal flats and wetlands protected by a string of barrier islands at the estuary mouth, and is fed by nutrients brought down by the Nagdong River. The salinity gradient in the estuary provides a good medium for biological activity. The favorable geographical and biological characteristics provide the migratory birds with the habitat and food supply they require during the winter months. The main areas of the estuarine habitat have been declared a National Monument by the Government, and hunting is strictly prohibited (see Annex 2).

3.14 During the design stage of this project, it was well recognized that adverse effects on the environment had to be minimized and the bird habitat preserved. Extensive environmental impact studies were carried out by NEDECO and, as a result, the land reclamation component was reduced from 600 ha to only 190 ha, bordering the Busan City developed area, and the three originally proposed design alternatives were abandoned. The revised design includes underflow and overflow gates in the barrage and a discharge sluice in the closure dam. This enables water circulation even at low flows and permits the discharge of adequate volumes of nutrient-rich water into the estuary. Fish passes in the wing walls were also added. Construction operations, particularly dredging operations, would be carefully controlled, with borrow and disposal areas selected to minimize adverse effects on the estuary. An Environmental Impact Assessment (EIA), was prepared by ISWACO and approved by the OOE (Annex 2, Attachment 1) contingent upon ISWACO establishing an Environmental Management Unit (EMU) to survey and monitor the bird habitat, (in cooperation with established environmental groups and

universities) and taking countermeasures to minimize adverse effects during and after construction. OOE will monitor results through quarterly progress reports. A further EIA is to be prepared for the use of the 190 ha reclaimed land. A Bank consultant reviewed the environmental impact of the project on the bird habitat. The consultant agreed with the OOE conditions and recommended that ISWACO establish an environmental management capability and ROK give additional protection to the estuary to prevent remaining wetlands from being further developed.

3.15 Measures required to protect the environment have been discussed with ISWACO, who agreed to establish and maintain the EMU satisfactorily. The EMU has already been established, including expatriate environmental experts supported by ISWACO's staff. ISWACO also agreed to establish an Environmental Management Section at ISWACO Headquarters to advise on environmental issues. This section, under the Director of Planning, would eventually supervise EMU and provide ISWACO the capacity to integrate environmental concerns in the construction of future projects. Quite apart from the environmental considerations arising from the construction of the Barrage, a major threat to the bird life is the population pressure to reclaim additional land from the sea. The present status of the area as a National Monument has not prevented this reclamation in the past. Under the project further protection under existing laws would be given to defined areas of wetland. This would limit further fishing and agricultural development, curtailing land reclamation in critical areas of the estuary. Assurances were obtained during negotiations that:

(a) Environmental actions recommended by OOE would be implemented by ISWACO (Annex 2, Attachment 1);

(b) EMU would monitor the estuarine environment and enforce conditions for its protection during construction;

(c) EMU would prepare a study by December 31, 1984, under TOR acceptable to OOE and the Bank, of the intertidal areas which should be fully protected. Based on this study, as reviewed by OOE and the Bank, MOC would establish not later than June 30, 1985, a zone in the estuary a "Natural Environment Preservation Area" under the National Land Use and Management Law of December 31, 1982,/1 and OOE would designate, not later than December 31, 1985, within this zone of the estuary a "Natural Ecological System Preservation Area" under Article 9, para. 3, of the Environmental Preservation Law of December 31, 1981. The proposed zone would be inside the boundaries of National Monument #179; and

(d) an Environmental Management Section would be established by ISWACO at headquarters not later than December 31, 1984.

/1 This is an intermediary legal step required before establishing a "Natural Ecological System Preservation Area."

Operation and Maintenance

3.16 ISWACO has considerable experience in the operation and maintenance of multipurpose dams. Key personnel of ISWACO from existing projects will be employed in the inspection, installation and performance testing of equipment in order to become thoroughly familiar with the equipment and its operation. The main contract also provides for on-the-job and overseas training of key ISWACO staff. The principles of barrage operation have been established in sufficient detail for project formulation and assessment of project benefits. However, further studies are needed to specify more detailed operating rules and to minimize any unfavorable ecological impacts from the barrage. The proposed barrage, although a relatively large structure, has a low (5 m) head and small storage volume and would not cause severe damage in the unlikely event of failure. Assurances were obtained from ISWACO that a suitable maintenance and inspection program for the barrage would be available for Bank review not later than December 31, 1986. ISWACO's proposal should include a description and schedule of the maintenance and inspection program.

Procurement and Disbursements

3.17 All civil works and equipment for the barrage, estimated at $81 million in 1983 dollars, have been procured through international competitive bidding (ICB) following Bank guidelines. Procurement of all supplies and construction for the barrage and appurtenant works were under one contract to ensure proper integration of the different project components and the earliest completion of the project. Technical specifications and the bidding documents were reviewed by the Bank. Advance contracting has been included, given the urgency to start the construction in October at the start of the 1983 dry season, to avoid a year's delay in project completion. Six joint ventures and four local contractors presented bids on August 10, 1983. The contract was awarded on September 10, 1983 with Bank concurrence. The Bank has made it clear that advance contracting was undertaken at government risk and Bank financing of the project was contingent on the Board's approval of this project. Advance contracting reduced the estimated project cost and foreign component since actual bids were 36% lower than engineers estimates. This is mainly the result of Korea's highly competitive construction industry and some alternative technical solutions proposed by the bidders. The leak detection equipment would also be procured following ICB procedures. Microcomputer hardware up to $400,000 in aggregate would be procured through prudent international shopping. All bidding packages over $100,000 equivalent would be subject to the Bank's prior review of procurement documents. Consultants for the project's supervision have alredy been hired, and consultants for the two national programs would also be hired following Bank guidelines.

3.18 The proceeds of the loan would be disbursed against: (a) 55% of the works contract for the barrage (which includes civil works and equipment); (b) 100% of local expenditures (ex factory cost) and 100% of the foreign expenditures for computer hardware and software, and equipment for leak detection and for monitoring the environment; (c) 100% of the initial mobilization payment for the Nagdong Barrage; and (d) 100% of the cost of consulting services. Retroactive financing has been included for the

engineering and environmental consultants, which are required to start working before the start of project construction. Retroactive financing is limited to consultant expenditures after October 1, 1983, totalling not more than 0.5 million (0.6% of the proposed loan amount).

3.19 Given the advanced stage of project preparation and contracting and the satisfactory implementation of projects in the sector, disbursement of the proposed loan is expected to take five years (1984-88), somewhat faster than the average time indicated by the disbursement profile for the country. The project Closing Date would be June 30, 1989. The estimated disbursement schedule is shown in Annex 6.

IV. THE BORROWER AND EXECUTING AGENCIES

The Borrower

4.01 The borrower will be the Government, which will relend $73.5 million to ISWACO. Signing of this subsidiary loan agreement would be a condition of loan effectiveness. A Project Agreement will be executed with ISWACO covering the Nagdong Barrage component. The Government will relend the balance of the loan ($5.0 million) through MOHA to the project cities for leak detection and institutional development. Relending terms and conditions would be the same as the Bank loan plus a 0.05% p.a. handling charge. The foreign exchange risk would be borne by ISWACO and the cities benefitting from the project.

Implementing Agencies

4.02 ISWACO would be the main executing agency for the Nagdong Barrage, and MOHA for the two national components. ISWACO is the borrower for Loan 1666-KO (Chungju Multipurpose Dam). This project is being executed satisfactorily and would be completed on schedule (December 1985). ISWACO was established on February 1, 1974, pursuant to the law for the promotion of industrial sites and water resources development, and undertakes development of: (a) industrial sites and special areas; (b) water resources for irrigation, flood control, power generation, industrial and municipal water supply; and (c) operates and maintains multipurpose dams and facilities to provide bulk water for industrial and municipal consumption. ISWACO succeeded the Korea Water Resources Development Corporation, established on November 1, 1967. ISWACO has planned and constructed and has completed or is about to complete five industrial estates or new cities (Ulsan/Onsan, Changweon, Yeocheon, Daeduk and Gumi), three shipyards, and five multipurpose dams (Soyang, Daecheong, Andong, Seomjingang and Namgang). Three industrial estates, one new town (Banweol) and one multipurpose dam (Chungju) are presently under construction. In addition to the Nagdong Estuary Barrage and the Hapcheon Dam, six other dams are expected to be built within the next 10 years. ISWACO also operates eight regional water supply systems (Seoul Metropolitan area, Ulsan, Pohang, Majin, Yeocheon, Daedug, Geoje and Gumi, Annex 11).

4.03 ISWACO is managed by a Board of Directors (Chart 2) consisting of a President, one Vice President and five Directors (Planning, Administration, Industrial Sites, Water Resources and Public Utilities), appointed for three-year periods, and one Auditor, appointed for a two-year period. ISWACO's President is appointed by the President of Korea. The Vice-President and Directors are appointed by the Minister of Construction. ISWACO has developed into a large and competent organization with 16 departments, 17 local offices and 1,214 employees of which 530 are in Daejeon headquarters and 684 in local offices. Many of ISWACO's 500 engineers have been trained abroad and, working together with foreign consultants, have acquired considerable experience in the design, construction, operation and maintenance of many large projects. Any loans applied for by ISWACO have to be approved by MOC.

4.04 ISWACO's chief sources of funds are periodic capital subscriptions by the Government, loans from KDB, foreign loans and revenues from its operations. Industrial sites together with related loan obligations are sold to users at cost.

4.05 ISWACO's operation is efficient, with administrative expenses representing 5% of the cost of the Industrial Sites, Dams and Water Divisions. Bulk water is measured at pumping stations and users' intakes. Reported unaccounted-for water is less than 5%. Meters are calibrated often and there are meter shops at different locations.

4.06 ISWACO's financial operations are in three main activities: industrial sites, dams and water supply. These operations are conducted independently with separate accounts. General ledger and payroll are computerized. ISWACO's basic data and accounting policies are satisfactory and follow the "Accounting Regulations for Government-invested Corporations". Financial results are produced in a timely manner, and detailed management reports summarize financial results and the status of projects. ISWACO's financial results are submitted to MOC and audited by its internal auditor and the National Inspection Board. Since ISWACO has loans from several international agencies (ADB, OECF and the Bank) its financial statements are also audited by an independent auditor, a large and respected Korean firm. Assurances were obtained during negotiations that ISWACO's financial statements would continue to be independently audited, and that a copy of the auditor's report would be sent to the Bank within six months after the end of each fiscal year. ISWACO has insurance against fire, as well as for vehicles, and is self-insured against other risks.

4.07 MOHA's Local Finance Division (LFD) will coordinate the design and implementation of the leak detection and institutional development programs and be responsible for hiring consultants and supervising the technical assistance and training provided to the cities. LFD, under an ADB sector loan, has strengthened its financial and technical capacity by hiring engineers and financial analysts to assist the WBs in the execution of

foreign-financed projects. In addition, the LFD would coordinate and provide support for the Busan City water and sewerage components which would be implemented, respectively, by the Water and Construction Bureaus of the city, with support from local consultants. Assurances were obtained during loan negotiations that within six months of the end of each fiscal year MOHA will submit a summary of these project component cost accounts, as audited by independent auditors acceptable to the Bank.

V. FINANCIAL ANALYSIS

ISWACO - Financial Performance

5.01 ISWACO is a corporation owned by the Government (95%) and the Korea Development Bank (5%). Its authorized capital is W 500 billion, of which W 280 billion ($370 million) was paid in as of December 31, 1982. ISWACO has been growing rapidly and its fixed assets increased 3.7 times in the last four years. ISWACO's main sources of funds have been Government equity contributions, loans from KDB, foreign loans and internal cash generation.

5.02 ISWACO's financial performance between 1978-82 has been generally satisfactory with a debt/(debt plus equity) ratio of 54% and a current ratio of 1.4. However, ISWACO's net income has only been 2% of its equity and its operating ratio was almost 100% due to the effect of the industrial sites division (para. 5.04). ISWACO's financial statements are shown in Annex 9, and a summary is presented in Table 5.1. ISWACO's corporate planning has been hindered by the lack of clear Government policies for its rates and tariffs. Under the project, financial targets for ISWACO's Water and Dams Divisions would be implemented (para. 5.09).

5.03 Until 1981 ISWACO was exempted from income and defense taxes, now charged at a rate of about 11% of net income. ISWACO's fixed assets and depreciation have not been revalued since 1977; depreciation is therefore underestimated and income overestimated. The Korea Assets Revaluation Law allows the revaluation of fixed assets when their estimated value exceeds 25% of the book value. Assets revaluation is detailed and requires the approval of Government auditors. ISWACO's fixed assets should be revalued to adequately gauge its financial performance, including rates and tariffs for services, and to avoid overpayment of taxes. Assurances were obtained during loan negotiations that the fixed assets of the Water and Dams Divisions will be reassessed not later than December 31, 1984, and that for purposes of rate analysis the value of fixed assets of these Divisions will be updated annually until the next formal revaluation, using 85% of the annual increase of the wholesale price index. This index is a good indicator for the cost of capital goods and 85% of this index would provide a conservative proxy of ISWACO's fixed assets until the following formal revaluation. ISWACO's revenues and expenses from its different divisions are summarized in Table 5.2.

Table 5.1: ISWACO'S SUMMARY FINANCIAL STATEMENTS (AUDITED)
(W million)

	1978	1979	1980	1981	1982
Operating Revenue	85,307	151,284	104,564	75,550	73,084
Less: Operating expenses (including depreciation)	85,600	150,061	104,422	73,458	71,369
Operating income (loss)	(-293)	1,223	142	2,092	1,715
Non operating income (net)	1,431	2,047	3,486	3,737	3,129
Net income	1,138	3,270	3,628	5,829	4,844
% operating ratio	100.3	99.2	99.9	97.2	97.7
Net income as percentage of equity	1.4	2.2	2.3	2.2	1.5
Current assets	19,547	37,825	26,816	36,415	46,698
Other assets	9,843	6,119	25,369	26,995	78,834
Net fixed assets	177,205	288,705	348,717	600,131	648,808
Total Assets	206,595	332,649	400,902	663,541	775,340
Current liabilities	13,238	25,984	41,390	48,681	54,295
Long-term debt	109,779	152,999	197,602	254,229	383,696
Reserves	2,723	4,269	5,272	98,325	8,651
Equity	80,865	149,397	156,638	262,306	328,698
Total Equity and Liabilities	206,595	332,649	400,902	663,541	775,340
Current ratio	1.48	1.46	1.54	1.34	1.36
% Debt/(debt + equity)	58	51	56	49	54

Table 5.2: ISWACO'S DIVISIONS, REVENUES AND EXPENSES (W Million)

Division	1981 Revenues	1981 Expenses /a	1981 Gross profit	1982 Revenues	1982 Expenses /a	1982 Gross profit
Industrial sites, new towns	35,931	35,947	-16	28,823	28,823	0
Water supply	19,423	18,402	1,021	32,099	24,943	7,156
Dams	15,189	11,752	3,437	11,030	12,692	-1,662
Other revenues/expenses	5,008	4,479	531	1,132	1,264	-132
Divisions' Total	75,551	70,578	4,973	73,084	67,722	5,362
General administration	-	2,880	-2,880	-	3,647	-3,647
Other income	5,475	997	4,478	4,875	940	3,935
Income taxes	-	742	-742	-	806	-806
Net income			5,829			4,844

/a Including depreciation.

Industrial Sites

5.04 ISWACO's activities before 1974 were only in the water sector, but its main activity during subsequent years has been the construction of industrial sites and new towns. With the completion of many of these projects, ISWACO's revenues and expenses from these activities are declining and explain the decrease of revenues from W 151 billion in 1979 to W 73 billion in 1982, with a corresponding reduction of expenses from W 150 to W 67.7 billion during this period. Industrial sites and new towns are financed by Government equity contributions and long-term loans from KDB. After construction these industrial sites, together with related loan obligations, are sold at cost. Therefore the net income and cash generation now depend on other ISWACO activities, namely those of the Dams and Water Supply Divisions. The appraisal's financial analysis is centered on these divisions.

Water Division

5.05 MOC finances all production and transmission systems for bulk and treated water supplies to more than one city (regional systems); these systems and those built by ISWACO are operated by the Water Division. This division also provides treated water to several industrial zones and some adjacent cities. Ninety-seven percent of its revenue is from the sale of raw water while treated water provides the remaining 3%. Presently ISWACO provides water to eight regional systems including Seoul. MOC is

preparing feasibility studies for three other regional systems for some 50 cities and towns, including a Third Stage Project for the Seoul Metropolitan area. This $300 million project is included in the financial projections for this division (Annex 8) and would be constructed between 1985-88. ISWACO's raw water sales are expected to increase from 900 to 1,300 million cu m per year between 1982-88. During the 1982 drought, ISWACO's sales of hydro-generated power were reduced from 988 to 614 GWH resulting in a deficit of W 1,660 million in the Dams Division (Table 5.2). This contrasts with the results of the Water Division, which increased its total water sold between 1981 and 1982 from 658 to 920 million cu m (40%) and increased its revenues by 65%, compensating for the poor performance of the power operations.

Bulk Water Tariffs.

5.06 ISWACO's tariffs for raw and treated water are satisfactory and include fixed charges for the basic contracted water capacity, metered charges varying with the volume used and surcharges for volumes used in excess of the contracted supply. ISWACO's water tariffs were increased 100% in the Seoul Metropolitan area between 1980/81. Slightly lower increases were approved for other areas to equalize prices for all cities in Korea (this cross subsidizes the smaller cities.) The present tariff was approved on December 21, 1981 as follows:

ISWACO'S WATER TARIFF (W/cu m)

	Basic consumption rate	Metered consumption rate	Total	Excess over basic consumption
Raw water	17	13	30	55
Treated water	50	9	59	70

Future Financial Performance of the Water Division.

5.07 Power expenses represent 68% of the total expenses of the Water Division. These expenses are expected to increase less than proportionally with the volume of water produced, because the main charge (for installed capacity) would remain constant until the completion of the Third Metropolitan Stage project. Other expenses are also expected to remain practically constant (in real prices) until the Third Metropolitan Stage project enters into operation. Large capital expenditures on this project would result in a marginal cost of W 80/cu m, compared with a present tariff of W 30/cu m. General expenses would increase less than proportionally because of economies of scale. Under the proposed covenant (para. 5.09), the Water

Division would have to increase its water charges by 31% in real terms between 1983-89. The Water Division would have a satisfactory financial position (Annex 8) with a working ratio of about 66%, debt service coverage ratios between 1.8 and 10 times, and a capitalization ratio of 11-19%. Excess cash generated by this division, accumulating to W 23 billion by 1987, would contribute to financing the large dams investment programs. Financial highlights for this division are shown in Table 5.3.

Table 5.3: FINANCIAL HIGHLIGHTS - WATER DIVISION

	1982	1984	1986	1988
Raw water tariff - 1983 prices W/cu m	34.6	33.0	33.0	37.0
Operational revenues (W million)	32,100	40,750	50,540	68,340
Operational expenses (W million)	21,080	26,950	33,250	40,450
Depreciation (W million), revalued	5,510	6,100	6,960	11,220
Net income (W million)	5,070	6,760	9,680	16,400
% Working ratio	66	66	66	60
% Rate of return (on revalued assets)	3.0	4.0	5.0	5.0
Capital expenditures (W million)	50	1,120	73,110	58,150
Debt service coverage (times)	5.5	5.2	6.6	10.7
% Debt/(debt + equity)	7	5	15	18

Dams Division

5.08 The Dams Division operates three Multipurpose Dams (Andong, Soyang and Daecheong). Fixed assets incorporated by ISWACO include only water supply, power and 30% of the cost allocated to agriculture. The cost allocated to flood control and 70% of the cost allocated to agriculture are not included in the fixed assets, but recovered by general taxes. The respective operational expenses for these services are subsidized by the power and water revenues. The Dams Division's revenues are:

(a) sales of bulk energy to the Korea Electric Power Company (KEPCO), which represent 85% of this division's revenues. ISWACO's power generation capacity would increase 135% in 1986 upon completion of the Chungju Dam;

(b) water charges to cities and industries using water from rivers regulated by ISWACO. The volume of water billed (including the Nagdong barrage water) is expected to more than double by 1988 (from 1,100 to 2,500 million cu m); and

(c) charges for irrigation; present billing of only 87 ha to be increased to 25,000 ha by 1988 (due to billing of present users and additional areas irrigated by new dams entering into operation).

Tariffs and Other Charges

5.09 Charges and tariffs for services of the Dams Division are low, resulting in a negative 0.3% rate of return on revalued assets in 1982. This reflects the difficulties in setting tariffs for powerful clients (KEPCO, the cities, agricultural users). Under the Chungju Multipurpose Project, ISWACO agreed to discuss with the Bank and implement by December 31, 1983, satisfactory tariffs for power./1 An overall financial performance target for all services under the Water and Dams Divisions is needed. The revenues of these Divisions should cover operation, maintenance and debt service and provide a reasonable contribution to future investments. Lack of agreed financial targets is a major shortcoming for ISWACO since its projects require a long construction period (up to seven years); but there are no criteria to set ISWACO's revenues and financial contributions during this period. Government agreement on setting a minimum financial performance target is an important institutional improvement. This objective would be achieved with a rate of return of 4-5% on revalued fixed assets in operation. This would provide a net internal cash generation of about 19% which is satisfactory considering ISWACO's huge investments (para. 5.11). Assurances were obtained during negotiations that ISWACO's tariffs and charges in the Water and Dams Divisions will be adjusted annually as needed to achieve a rate of return on revalued net fixed assets in operation not lower than 4% in 1984 and 1985 and 5% thereafter.

5.10 ISWACO's charges are proportional to the cost of each system. Power charges are W 9.5/kWh in Soyang, W 23.8/kWh in Daechoeng, and W 26.7/kWh in Andong. Under the proposed rate of return power charges would double in real terms between 1982-86 (from W 13.9 to 29.1/kWh)./2 Water charges are W 1.3/cu m in Soyang, W 2.7/cu m in Andong and are specially contracted in Daecheong. Water made available by the barrage is expected to be charged at about W 7/cu m. The total average water tariff would increase 74% in real terms (from W 1.9/cu m to W 3.3/cu m in 1983 prices). These tariff increases are large but are considered feasible, and are needed to provide ISWACO with resources to participate in financing a large investment program of $1,090 million between 1983-88, including the Chungju Dam ($480 million), the Nagdong Barrage ($167 million), and the Hapcheon Dam ($240 million). Another six dams (Annex 1) are in different stages of feasibility analysis, and some of them would be built during the next ten years.

/1 In discussions with Bank staff in June 1983, ISWACO informed them that a Korean firm had been engaged to undertake the cost allocation study necessary to establish an apropriate tariff for the electricity to be sold from Chungju Dam, now expected to commence commercial operation in mid-1985. The proposed tariff is likely to be available for Bank review by end-October rather than June 30, 1983 as originally agreed.

/2 ISWACO's power tariffs are negotiated with KEPCO and if necessary set by MOC in consultation with EPB. ISWACO expects to increase its average power tariff from W 13.8/kWh to W 18.4/kWh in 1983 retroactively to January 1, 1983.

Future Financial Performance of the Dams Division

5.11 Under the proposed revenue covenant (para. 5.09), the financial position of the Dams Division would be satisfactory (Annex 7): its operating expenses would represent less than 20% of its revenues, its debt service ratio would exceed 1.4, and its debt/(debt plus equity) ratio would be below 26%. ISWACO's overall financing plan for its Dams Division is shown in Annex 7, Table 5. The total investment between 1983-88 is W 850 billion ($1,090 million). The Bank, through Loan 1666-KO and the proposed project would finance 11.3% ($124 million), OECF 10.4%, other loans 1.9%, government equity contributions 57.6% and ISWACO internal generation 18.8%. Additional dam investments and their financing could affect ISWACO's financial position. Assurances were obtained during loan negotiations that ISWACO would not incur any additional long-term debt without prior Bank concurrence, unless its debt service coverage exceeds 1.3 in any calendar year. Financial highlights for the Dams Division are shown in Table 5.4.

Table 5.4: FINANCIAL HIGHLIGHTS - DAMS DIVISION

	1982	1984	1986	1988
Power rate (W/kWh, 1983 prices)	14.9	27.1	29.2	27.5
Municipal and industrial rate W/cu m, 1983 prices	2.1	2.6	2.6	2.4
Operational revenues (W million)	10,430	23,456	51,969	77,855
Operational expenses (W million)	4,074	5,709	9,213	12,247
Depreciation (W million)	7,200	7,764	16,191	25,121
Net income (W million)	-3,357	7,568	18,304	27,602
% Working ratio	39	24	18	16
% Rate of return (revalued)	-0.3	4	5	5
Capital expenditures	91,686	240,470	131,122	77,529
% Capital expenditures to net fixed assets	38	95	22	9
Debt service ratio	1.0	1.8	2.7	1.8
% (Debt/debt + equity)	29	23	22	18

Reporting Requirements - Monitoring Indicators

5.12 In order to permit the satisfactory monitoring of the investment program and financing plans, assurances were obtained that:

(a) ISWACO would send to the Bank five-year financial projections for the Water and Dams Divisions before August 31 of each year. The projections would include an income statement, statement of cash flow, balance sheet with details of water and power demand, total investments and financing resources;

(b) ISWACO would establish, not later than March 31, 1984, a system of monitoring indicators and targets satisfactory to the Bank (Annexes 7 and 8), and send to the Bank not later than August 31 and February 28 of each year semiannual information on these indicators, the compliance with loan covenants and the analysis of project execution and cost; and

(c) ISWACO and MOHA would prepare a project completion report satisfactory to the Bank, not later than six months after the loan closing date.

VI. PROJECT JUSTIFICATION

Introduction

6.01 The proposed project meets urgent needs to make more water available for 37 cities and towns in the Nagdong River Basin, including Busan and Daegu (the second and third largest cities in Korea), and Ulsan/Onsan (an important industrial city). The Nagdong River Basin has 30% of the country's population and generates 40% of its industrial production. Korea's monsoon weather results in three months of intense rain followed by a long dry period. Variable weather conditions exacerbate this problem and subject most cities to water shortages, especially in the lower reaches of the river. Salinity intrusion that reaches up to 44 km upstream of the river mouth is a major problem. To try to maintain a salinity level below an acceptable standard for drinking water (300 ppm), a minimum river flow of 40-50 cu m/s is being wasted to sea. This flow, plus variable conveyance losses, has to be supplied from the Andong Dam 370 km upstream. The construction of the Nagdong Barrage would eliminate the problems of salinity for Busan, Ulsan/Onsan and the large Gimhae agricultural polder, and would allow the use of about 25 cu m/s of this water by these and the other cities in the Nagdong basin.

6.02 Major institutional improvements are also included: (a) under the project, agreements have been reached with the Government to set financial targets for ISWACO's Water and Dams Divisions and to implement marginal cost pricing for the water made available by the barrage; (b) long-term institutional and environmental objectives would be achieved by the establishment in ISWACO of an Environmental Management Section which should develop expertise to reconcile the construction of future projects with environmental concerns; and (c) the two national components, the leak detection and institutional development programs, would transfer appropriate technology in leak detection and control (saving capital and operating expenditures in water supply), and in accounting and finance, (improving accounting, financial management and operations of the WBs). The development of common microcomputer software for basic accounting and management needs would correct present accounting deficiencies, and avoid a duplication of effort and resources resulting from each city trying individually to develop, with limited financial and human resources, the same programs. These two

national components are expected to have a large multiplier effect and eventually improve the operation, management and financial administration of the WBs in Korea.

Least Cost Solution

6.03 The Nagdong Barrage was identified in many studies (UNDP/FAO-1972, FAO/NEDECO-1976, NEDECO-1981, NEDECO-1983) as the least-cost solution to prevent salinity intrusion and provide additional water. Other more costly alternatives include upstream storage dams, reservoirs in the cities and relocating water intakes further upstream. Furthermore, recent salinity data show that the water supply intakes for the downstream cities (Busan, Ulsan/Onsan) would experience unacceptably high salinity levels even if high river flows (in excess of 60 cu m/s) could be maintained. Upstream storage dams would not be able to reliably provide these flows, and it would be a wasteful use of scarce water.

The Nagdong Barrage Benefits

6.04 Municipal and Industrial Water. Water works expansions are under construction in the main cities in the basin (including Busan, Masan, Changweon, Jinhae, Daegu, etc.). Under present demand conditions, the pumping of water has to be stopped for hundreds of hours in the cities of Busan and Ulsan. These two cities represent half of the population and 60% of the municipal and industrial water demand on the river (Annex 3). The river flow available for salinity repulsion under present dry weather conditions is about 40 cu m/s. After the barrage is operational, a flow of 15 cu m/s would be maintained to allow for dilution, navigation, fisheries and to provide nutrients to the estuary area. The remaining 25 cu m/s (enough to supply water to 10 million persons at 200 lpcd) would be available to the cities and to agricultural users (para. 6.05). The benefits of this component were estimated at the value of constructing the least-cost alternative (upstream relocation of the water intake) that would provide water within tolerable salinity levels. Further details are provided in Annex 10.

6.05 Agriculture. The Gimhae polder area is the largest single irrigated area (15,000 ha) and one of the most productive agricultural zones in Korea. Salinity intrusion forced the abandonment of the original water intake at Daedong. The present intake, Weolcheon, sited 2 km upstream of Daedong but 5 km below the Busan intake, has experienced salinities over 2,000 ppm, which would result in gradual deterioration of crop yields. In fact, NEDECO's computer simulations forecasted that critical agricultural salinity levels (1,200 ppm) would be reached at the agricultural intake one to two years earlier than at the municipal intake. Under the project, the Gimhae polder would be partially surrounded by fresh water and the Daedong intake would be used again and would provide water by gravity. The availability of fresh water makes drainage (not included in the project) technically and economically feasible. This would result in an intensification of agriculture and a higher crop yield in the polder area. Irrigation upstream of the Gimhae Polder is expected to increase slowly and has not been included in the project benefits.

6.06 Land Reclamation. Dredging associated with the project produces sand useful for land reclamation and allows the reclamation of 190 ha within the municipal boundaries of Busan. This prime land, adjacent to fully urbanized areas with all public services and within minutes of downtown Busan, is extremely valuable for this city given the scarcity of land for its future development.

6.07 Bridge Function of the Barrage. A four-lane roadway (with a possibility of additional two future lanes) has been designed on the barrage. This bridge function would improve the accessibility of the right bank area and reduce travel distances. It will also reduce traffic congestion costs on the three existing river crossings. The barrage crossing will result in about 3% of the Gimhae polder area (450 ha) being urbanized by the end of the decade, thus increasing the value of this land. The location of the barrage fits into the existing and planned road network of Busan.

6.08 Power Benefits. The Andong Dam (926 million cu m, or 7% of the annual river flow) has an after-bay weir. The hydropower plant is equipped to pump water back to the main reservoir during off-peak hours for re-use during peak hours. The barrage eliminates the concern for a large, continuous flow now required for salinity repulsion, and eliminates the pump back energy cost.

Project Cost Allocation

6.09 The present value of the estimated benefits and alternative costs for the multipurpose functions of the barrage are shown in Annex 10, Table 2. The justifiable expenditure for each component is the lower of these values. The joint cost is the total cost less the separable expenditures, and is allocated in proportion to the remaining justifiable expenditures. The cost allocation shows that 79% of the cost should be recovered by ISWACO's water and power charges and land sales. The agriculture and bridge function benefits (including land appreciation) would be recovered by the Government through established taxes and represent 21% of the cost of the barrage.

Marginal Cost of Water

6.10 NEDECO's original report estimated that water supply failure on the Nagdong River would be in 1984. However, water flows have been insufficient to maintain a salinity level below 300 ppm since 1977. This problem has continued and reached a critical level in 1982, which is therefore considered the failure year. Additional upstream water usage after 1982 would greatly increase the water problems for cities nearer the river mouth. The estimated incremental water use after 1982 and the construction and operating costs of the barrage are shown in Annex 10, Table 4. The marginal cost of water is W 8.3 for a discount rate of 10%. Although this price is 3 times higher than present charges by ISWACO in the Nagdong River (W 2.7/per cu m), it is affordable, representing only 4% of the water tariff for treated water in Busan. Although the application

of marginal cost pricing to this project will have only a relatively small impact on ISWACO's overall revenue, the acceptance and demonstration of this principle is a major institutional innovation, which, when extended to future projects, would improve ISWACO's capacity to self-finance additional water works and would promote efficient use of water resources in Korea. Letters of understanding have already been signed by the main beneficiaries (Busan and Ulsan/Onsan) on cost recovery. These letters establish: (a) that the users confirm that the barrage will benefit their respective cities; and (b) that upon project completion (by 1988), the cost would be levied to all municipalities and industries increasing their water usage after 1982. Assurances were also obtained from ISWACO that upon completion of the barrage, water charges would be levied on all cities which increased their water usage after 1982. Water charges would be based on the average long-term marginal cost (of the costs allocated to water supply) at a discount rate acceptable to the Bank.

Economic Rate of Return

6.11 The Economic Rate of Return (ERR) for the Nagdong Barrage, which represents 95% of the project cost, is estimated at 24% (Annex 10, Table 5) No ERR was estimated for the national components which are small and distributed in several cities. Sensitivity analysis shows that the ERR would be 22% if the water supply benefits are reduced 10%. The ERR would still be 10% with the following switching values: (a) 89% reduction in water supply benefits; (b) 137% reduction in land reclamation benefits; and (c) if the land reclamation, bridge and power benefits are excluded. These rates of return are satisfactory and are considered conservative estimates of the project ERR, since some water supply benefits (like the improvement of the living standards of the present population, which would receive reliable, saline-free, water supply) are difficult to quantify and were not included in the analysis.

Population Served

6.12 The main beneficiary would be the city of Busan, whose programs for improving water services will have to be curtailed if no additional water is available. Busan is already suffering from salinity problems, which result in discontinuous supply and rationing and may cause considerable damage to installations using this water. About one million more persons would receive water in Busan by 1988, including 300,000 in relative poverty./1 Overall, the project would improve the water supply to about 7.8 million persons presently depending on the unreliable supply of the Nagdong River, and would provide the capacity to serve about 4 million more persons by 1992. Most of the population without water or with rationed service is of low income and about one million of them are in relative poverty.

/1 Persons with incomes below one-third of the country's average per capita income.

Project Risks

6.13 There are no special risks in the project. However, investments in other projects could reduce the annual budgetary allocations and slow down project implementation. This is not considered likely given the high priority accorded to this project by the Government. Government contributions have been confirmed (para. 3.09). In addition, there is a risk that Busan water works extensions, which have already started, and the Jang Lim interceptor sewer could suffer some delays. However, the Government has provided assurances that these works will be completed by December 31, 1987, well before the barrage starts operating in 1988. Environmental risks have been minimized by studies and special conditions included in the project (para. 3.15).

VII. AGREEMENTS REACHED AND RECOMMENDATIONS

7.01 Assurances were obtained from the Government during loan negotiations that:

(a) Busan complementary water and sewerage works would be completed before December 31, 1987 (para. 3.04);

(b) Government contributions for the project would be provided in a timely manner (para. 3.09);

(c) a zone of the Nagdong Estuary would be declared a "Natural Ecological System Preservation Area" to protect the estuarine environment (para. 3.15); and

(d) MOHA's component project cost accounts would be audited (para. 4.07).

7.02 Assurances were obtained from ISWACO during loan negotiations that:

(a) ISWACO's Water and Dams Divisions would achieve a satisfactory rate of return (para. 5.09);

(b) environmental protection actions would be implemented (para. 3.15); and

(c) a maintenance and inspection program for the barrage would be available for Bank review not later than December 31, 1986 (para. 3.16);

(d) fixed assets would be revalued not later than December 31, 1984 (para. 5.03);

(e) ISWACO would not incur additional long-term debt unless debt service coverage exceeds 1.3 in any calendar year (para. 5.11);

(f) audit statements (para. 4.06) and periodic reports and monitoring indicators (para. 5.12) would be sent to the Bank; and

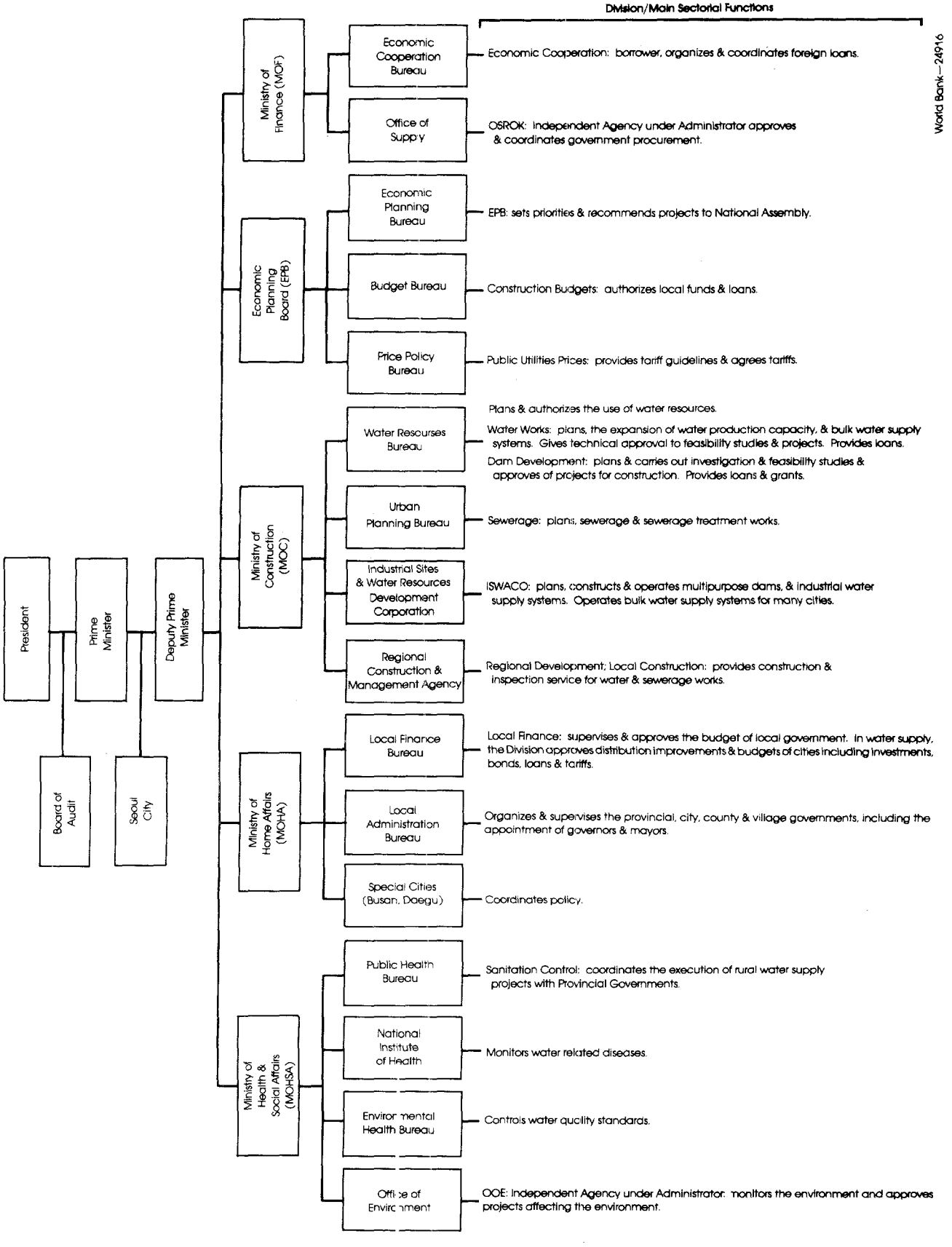
(g) upon completion of the barrage, the water made available by the barrage would be priced at its marginal cost (para. 6.10).

7.03 Signing of a subsidiary loan agreement between ISWACO and the Government would be a condition for loan effectiveness (para. 4.01).

7.04 With the above agreements and conditions the proposed project would be suitable for a Bank loan of $78.5 million, for a term of 12 years, including a grace period of 4.5 years at the standard variable interest rate. The borrower would be the Republic of Korea.

CHART 1

KOREA
SECOND WATER SUPPLY PROJECT
Ministries and Main Functions in the Water Supply and Sanitation Sector



KOREA
SECOND WATER SUPPLY PROJECT
ISWACO's Organization Chart

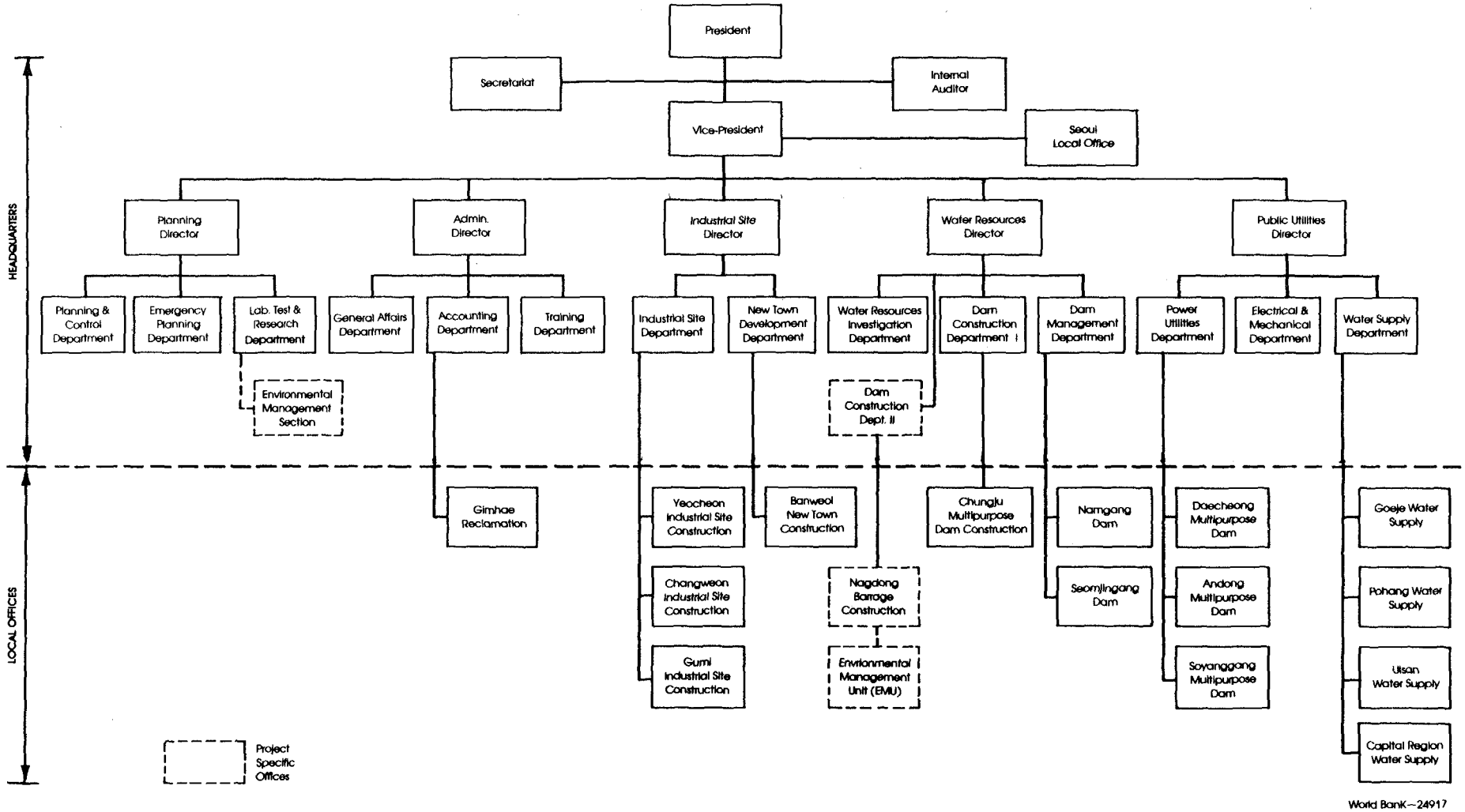


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CHART 2

KOREA

CHART 3

SECOND WATER SUPPLY PROJECT

PROJECT EXECUTION SCHEDULE a/

ACTIVITIES	VALUE MILLION 1983 $	1983	1984	1985	1986	1987	1988
		MAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND
1.00 NAGDONG BARRAGE: b/	123.00	PPPBBA					
1.10 PREPARATORY WORKS	4.42	65	75	85	100		
1.20 EARTHWORKS:	24.78	10	60	70	90	100	
1.21 Building Pit	3.32		20	40	70	100	
1.22 Earthworks (excl.reclamation)	16.29		10	40	70	100	
1.23 Land Reclamation	4.04				40	95	100
1.24 Closure Dam (Incl.Protection)	1.15		20	40	70	95	100
1.30 PROTECTION WORKS	11.05						
1.40 BARRAGE:	24.97	13	60	100			
1.41 Pilling	8.16		10	60	100		
1.42 Piers and Windgwalls	6.18			80	100		
1.43 Sills	2.22			30	100		
1.44 Bridge Works	2.89		5	45	85	100	
1.45 Gates & structural steel	5.53						
1.50 APPURTENANT WORKS	9.36		10	15	85	100	
1.51 Navigation Lock	4.44		10	15	85	100	
1.52 Discharge sluice	2.16		10	15	85	100	
1.53 Operation building	.27					90	100
1.54 Road Works	1.77		10	15	85	100	
1.55 Viaducts	.72			20	70	90	100
1.60 ELECTRIC WORKS	1.18			20	70	90	100
1.65 MECHANICAL WORKS	5.43						
1.70 LAND ADQUISITION	8.34	20	80	100			
1.75 COMPENSATIONS & DUTIES	7.76	10	70	90	100		
1.80 ENVIROMENTAL MANAGEMENT	1.86	10	30	50	70	90	100
1.90 PROJECT MANAGEMENT	12.21		30	50	75	95	100
1.95 MICROCOMPUTER HARD/SOFTWARE	.10			50	100		
2.00 NATIONAL COMPONENT:	6.63						
2.10 LEAK DETECTION PROGRAM	5.59		40	80	100		
2.11 Consultants	3.81		BBAI				
2.12 Training	.57		30	80	100		
2.13 Equipment	1.21		50	100			
2.20 INSTITUTIONAL IMPROVEMENTS	1.04		20	60	100		

a/ P = Prequalification, B= Bidding, A= Award, Numbers indicate the cumulative percentage of works completed

b/ Single bid for equipment and civil works for the Barrage.

KOREA

SECOND WATER SUPPLY PROJECT

Main Multipurpose Projects in Korea

1. The main multipurpose projects in the basin of the four largest rivers, the Han, Nagdong, Geum and Yongsan, are:

(a) Han Basin. The studies for the Han River Basin, completed in 1971, were financed by USAID and formulated a comprehensive plan for the development of the basin's water resources. Existing projects in the Han Basin include the Hwacheon Project (1940), the Soyang Gang Multipurpose Project (1973) and several smaller hydroelectric projects. The Chungju Multipurpose Dam, financed by Loan 1666-KO, is scheduled to be completed in 1986 and will provide almost complete regulation of the runoff from 26% of the catchment area of the Han Basin, and generate 460 MW of peaking capacity.

(b) Nagdong Basin. The studies for the Nagdong Basin were financed by FAO and completed by NEDECO, a Netherlands consulting firm, between 1966 and 1977. The first phase included the construction of the Andong Multipurpose Project, completed in 1976 and financed by ADB. The project finances the construction of the following phase, the Nagdong Barrage, while the construction of the Hapcheon Dam (being financed by OECF) is scheduled between 1984-1988.

(c) Geum Basin. A study of the Geum Basin was completed in 1972. The only major reservoir site in this basin, the Daecheong Dam, was completed in 1981. The development of an estuary dam near the mouth of the river has been studied under the Seeds Project (Loan 942-KO).

(d) Yong San Gang Basin. The first stage of the development plan of this basin, the Yong San Gang project was completed in 1978, financed by Loan 795-KO. The second stage, financed by Loan 1364-KO, is scheduled to be completed in 1984.

2. To reduce the large toll in human lives and property resulting from floods, and to provide additional water for urban, industrial and agricultural demand, while increasing hydroelectric generation capacity, ISWACO is planning to build seven additional large multipurpose dams which are expected to be in operation by the 1990s. Existing and proposed ISWACO projects are summarized in Table 1.

Table 1: EXISTING AND PROPOSED MULTIPURPOSE DAMS (UNDER ISWACO)

River basin	Dam site	Height (m)	Crest length	Capacity p.a. (mln cu m) Total	Flood control	Irrigation	Mun. & ind.	Electricity Generation: Installed capacity (MW)	Energy (max) (GWh/a)	Energy (1982) (GWh/a)	Completion date/construction period	Project cost (billion Won)
Existing												
Seomjin	Seomjingang	64	344	466	28	122	378	29	166	N/A	1965	5.2
Nam	Namgang	21	975	189	42	59	97	13	43	N/A	1970	6.9
Han	Soyang	123	530	2,900	500	-----1,213------		200	353	208	1973	32.1
Nagdong	Andong	83	612	1,248	110	-------926------		90	158	46	1976	40.4
Geum	Daecheong	72	495	1,490	250	349	1,300	90	240	47	1980	155.7
	Subtotal			6,293	930	--- 4,444 --		422	960	-		240.3
Under Construction												
Han	Chungju	97.5	464	2,750	600	551	2,829	460	844	-	1978-86	247.4/a
Proposed												
Nagdong	Hapcheon	93	482	794	72	-------552------		80	183	-	1984-88	180/b
Seomjin	Juam	66	337	892	59	-------504------		20	25	-	1985-89	164)
Han	Imgyae	83	280	280	10	-------237------		100	300	-	1985-90	194)
Nagdong	Imha	87	376	1,060	100	-------500------		50	95	-	1986-90	138)/c
Nagdong	Hamyang	94	402	259	8	-------201------		13	93	-	1987-91	84)
Han	Hong Cheon	80	351	1,314	52	-------571------		90	183	-	1987-91	187)
Geum	Myung Cheon	61	314	910	106	-------670------		50	130	-	1988-91	119)
	Subtotal			5,509	407	-----3,207------		463	1,009			1,066.0
	Total			14,552	1,937	----11,031------		1,345	2,813			1,580.7

/a 1979 cost estimates.
/b 1982 cost estimates.
/c Feasibility studies and large local and foreign fund requirements are likely to postpone several of these projects.

KOREA

SECOND WATER SUPPLY PROJECT

The Environment - Nagdong Estuary

1. The Nagdong estuarine environment, an area designated as National Monument #179 since 1966, consists of some 240 sq km of farmland, fresh, brackish and tidal waters, delta islands, sand spits and mudflats, both in the main river and in the tidal estuary (see Map 2, and Figure 1). The city of Busan bounds this area on the east (left) bank of the river. Agricultural development during this century, including dikes and river control structures, has resulted in the reclamation of some 15,000 ha (150 sq km) of prime farmland mainly on the west bank. The tidal reach extending some 60-70 km upstream of the proposed barrage site at Hadan is characterized by a decreasing salinity gradient with important agricultural and city water intakes 15-25 km upstream from Hadan. The west bank and the large delta island of Elsukdo are farmed intensively all year round. East bank development includes important commercial and industrial areas of Busan city including the major Sasang Industrial complex. Both river banks are diked for river training and flood control, and the river runs in a well defined channel. The wetlands on both banks between dike and river have also been reclaimed and are intensively cultivated.

2. The lower southern portion of Elsukdo Island, the mudflats and sand bars in this area, as well as the river itself and the numerous waterways like the Jukring Gang (another delta branch of the main river converted into a freshwater lake by sluice gates at both ends, Daedong and Nogsan) in the agricultural polder area, provide winter resting, feeding and stopover grounds for numerous species of migratory waterfowl. This zone also contains some important fish and seaweed farms. Being a transitional zone from fresh to sea water and receiving nutrients from sediment load carried by a well aerated slow moving river, the area is rich in plankton, algae and bottom flora and fauna. These support the bird and fish life in this zone. There is also a well enforced and observed ban on hunting over the whole designated area.

3. The Nagdong estuary though not large by international standards is the main bird habitat in Korea. A major concern in the preparation of the project has been the protection of the environment. Three originally selected alternative sites with extensive land reclamation were abandoned on environmental grounds. The ecological aspects were studied by NEDECO, and the ornithological problems were analyzed by a consultant hired by the Bank. The main concerns and solutions adopted are:

(a) Land reclamation disturbing the habitat of migratory birds. This was curtailed, and now includes only 190 ha, about one third of the area recommended by the original feasibility study. The area retained for reclamation borders developed areas of Busan City and has been excluded from National Monument #179 by the Ministry of Culture and Information. No land reclamation is included in the right bank of the river.

(b) Increased industrial pollution resulting from increased water retention time. Under the project the Jang Lim interceptor sewer will be built by Busan City before December 31, 1987 to convey industrial and domestic waste beyond the barrage (para. 3.04). Busan's City plan includes an outfall treatment plant. These works should actually improve the environment, reducing or eliminating altogether the pollution load from the Sasang industrial complex and developed areas bordering the river.

(c) Loss or reduction of tidal flats. This is considered a transitory problem, and given the low flows of water after barrage construction, it is expected that the tidal flats would actually increase and stabilize some years after project completion.

(d) Loss of nutrients because of the limited outflows. This problem, which existed in the first three alternatives considered, has been minimized by the inclusion of underflow and overflow gates in the barrage and of a discharge sluice in the right river branch incorporated in the closure dam.

(e) Disturbance of birds by traffic or human activities. A ban on hunting has been strictly enforced. This has resulted in birds being unafraid of humans; they stay undisturbed as close as within 100 meters of urbanized areas.

4. An Ecological Impact Assessment (EIA) was prepared by ISWACO for OOE, based on NEDECO recommendations. OOE approved the project subject to conditions designed to minimize any adverse influence on the environment (see Attachment 1). These conditions are designed to ensure that ISWACO would protect the bird habitat. They require the establishnment of control measures, both during and after barrage construction, based on quantitative and qualitative analyses of changes in the principle parameters which are relevant to maintaining the estuary as an attractive habitat for migratory birds; water quality (chemical and biological), sediment movements and morphology of the river and estuary, flora and fauna and distribution of tidal and river currents. They also require that the planning for the marketing and use of reclaimed land takes into account environmental considerations.

5. ISWACO will comply with these conditions mainly through an Environmental Management Unit (EMU), operating at the Busan Project Office, which has already been established and staffed satisfactorily. The core staff of this Unit consist of an Environmental Management Specialist (an expatriate supplied by NEDECO) and a wetland biologist and water quality specialist to be recruited locally. This core staff will be supported by local and foreign specialized staff as required. This core team will be responsible for planning and executing the required studies in cooperation with environmental associations and universities and monitoring and controlling construction operations to minimize adverse effects. ISWACO will also establish an Environmental Management Section at Headquarters by December 31, 1984 under the Director of Planning. This section will be responsible for overseeing environment-related activities of the EMU at the Busan Project Office and will be developed for managing the environmental impact of all ISWACO projects in close cooperation with OOE. The project provides funds of about US$1.9 million for the environmental management of the Barrage Project, including laboratory equipment and training.

6. ISWACO is discussing with Busan City arrangements for the planning, servicing and marketing of the 190 ha of prime land reclaimed under the project. The first parcels of reclaimed land are expected to be available for marketing by the end of 1985 and ISWACO will submit an EIA on the use of this land to OOE.

7. A main concern with respect to the environment is the population pressures generating a demand for reclamation of more urban and agricultural land. In the Nagdong estuary, these pressures could lead to the reclamation from the sea of areas of the estuary which may be essential for the preservation of the bird habitat. The shallow intertidal areas of the estuary bounded by the Gimhae polder to the north and the barrier islands to the south are vulnerable in this respect. The project therefore requires a study, to be conducted by the EMU, in accordance with TOR to be reviewed by OOE and the Bank, to identify areas which are vital for the continued preservation of the bird habitat. Based on the results of this study, MOC should establish, not later than June 30, 1985 a Natural Environment Preservation Area in the Nagdong Estuary (under the National Land Use and Management Law of December 31, 1982). OOE should then designate not later than December 31, 1985 a Natural Ecological System Preservation Area within the Natural Environment Preservation Area (under the Environmental Preservation Law of December 31, 1981) (para. 3.15). Figure 1 shows the features of the estuary and a tentative definition of the areas to be protected under the above laws. The designation of these areas as preservation areas by MOC and OOE will ensure their continued availability under controlled environmental conditions as a habitat for migratory birds.

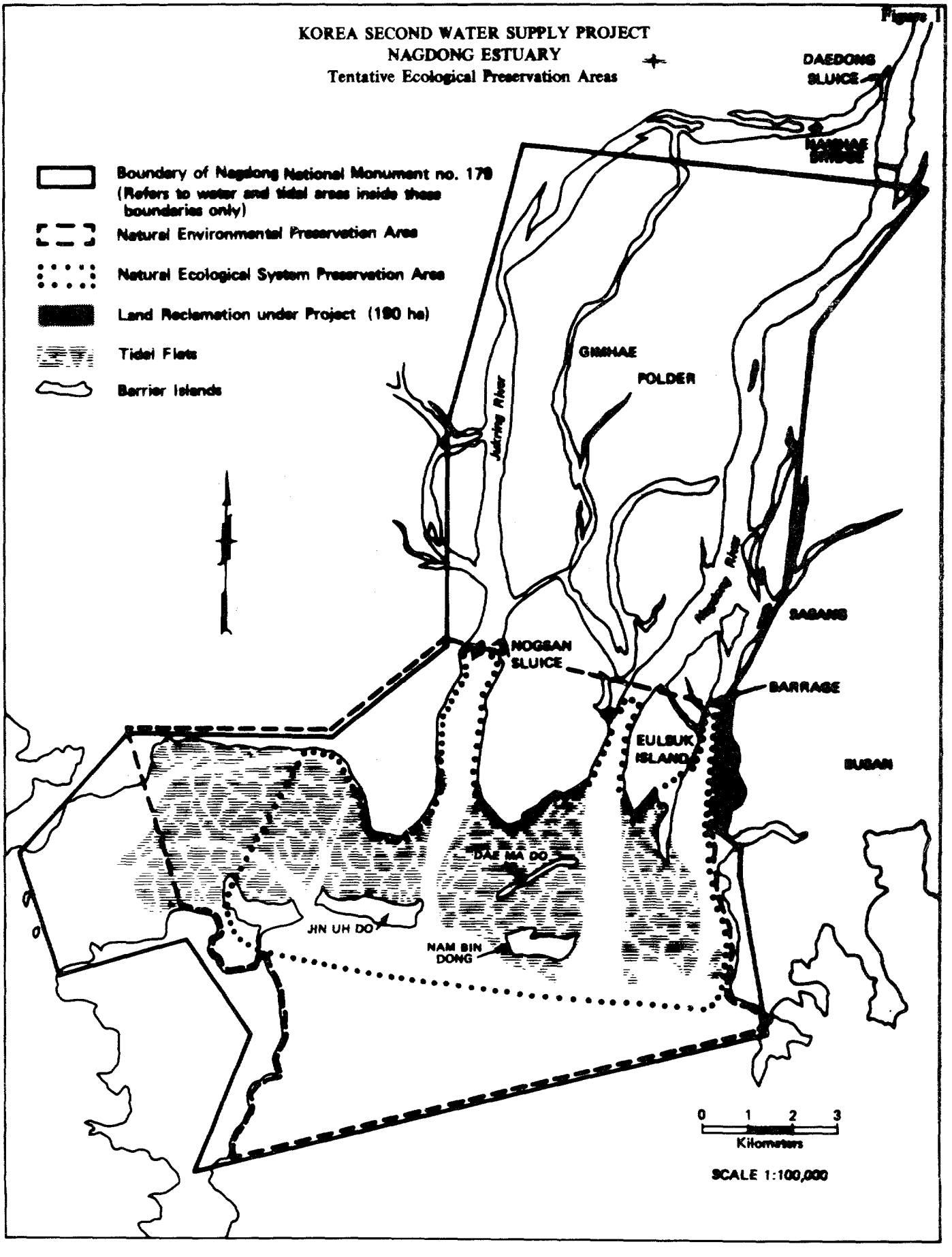
8. An important task of the EMU will be to ensure that the contractor responsible for barrage and ancillary works construction (all major works are packaged under a single contract) observes all the conditions for environmental preservation laid down in the conditions of contract. Specific

clauses in the specifications relate to the methods, equipment and techniques to be employed, the control of noise and soil, water and air pollution and the preservation of the project area in its present condition. Particular attention is paid to the control of dredging operations to minimize effects on the estuary. This is the first time that a major contract in Korea requires a contractor to include in his bid price allowances for environmental preservation during construction.

9. The quality of water in the limited storage reservoir (50 million cu m) created by the barrage has been studied and reported on by the consultants, NEDECO. The main conclusion was that maximum allowable domestic and industrial waste discharges into this reservoir area would have been exceeded at the present rate of development by 1988 when the barrage is due to be commissioned. It was therefore necessary to ensure that domestic and industrial wastes from Busan, mainly from the Sasang Industrial area, would be intercepted and discharged at a point well downstream of the barrage, preferably after adequate treatment. Busan City is planning to construct, before December 31, 1987, the Jang Lim Sewerage scheme which consists of a main interceptor sewer (15.5 km long) with lift stations along the left river bank to intercept domestic and industrial wastes from Gupo in the north, Sasang, Hadan and Jang Lim areas in the south to the proposed sewage treatment plant and outfall at Jang Lim about 2 km downstream of the barrage (see Map 2 and Annex 12). These works would effectively improve the water quality in this stretch of the river and would remove any danger of pollutants interfering with operation of water intakes at Mulgeum and Maeri, 20-25 km upstream of Sasang. A dissolved oxygen level of over 4 mg/l can be maintained in the reservoir, even under minimum flow and hot weather conditions, adequate to support fish life and prevent anaerobic decomposition of sediments. Eutrophrication may result in seasonally high concentrations of plankton and algae growths in the lower reservoir. The water intake at Mulgeum, however, is not likely to be affected. For flushing out of the reservoir and to provide for some mixing and a precise control of the water release rate for estuary management purposes, four of the ten radial gates controlling the barrage have been designed to operate as overflow weirs and all ten gates have provisions for controlled underflow. A discharge sluice has also been provided in the right river branch closure dam to provide for flushing out of this portion of the reservoir and provide nutrient rich water to the western side of the estuary.

Figure 1

KOREA SECOND WATER SUPPLY PROJECT
NAGDONG ESTUARY
Tentative Ecological Preservation Areas



KOREA

SECOND WATER SUPPLY PROJECT

Environmental Conditions to be Implemented

OOE conditions	ISWACO actions	Other actions
Bird research (Census, food and migrating habits)	Establish Environmental Management Unit (EMU) at Busan; core staff: environmental management specialist (expatriate 24 man-months), wetland biologist, water quality specialist (appointed in August 1983).	OOE and Bank to review TOR for and results of EMU intertidal area study
Biological and physical studies	Establish liaison with universities and local and international conservation associations for assistance in studies.	MOC to establish "Natural Environmental Preservation Area" under Land Use Management Law (by June 30, 1985).
Quantitative and qualitative morphological survey	Establish Environmental Management Section at Headquarters (by December 31, 1984).	OOE to establish "Natural Ecological System Preservation Area" under Environmental Preservation Law (by Dec. 31, 1985).
Pollution analysis	Training of key local staff in environmental management.	Busan City and Ministry of Culture and Information have excluded the 190 ha earmarked for reclamation from boundary of National Monument #179
Control plans to minimize adverse effects during and after construction	Establish survey and observation towers.	
Cooperation with Nagdong River Wild Bird Protection Association and Japan Wild Bird Association	Establish detailed plans for dredging requirements.	
Quarterly progress reports	EMU to monitor and study environmental factors and operations and establish conditions for environmental protection during and after construction.	
Use of reclaimed land subject to separate EIA	EMU to study, under TOR acceptable to Bank, intertidal areas which should be fully protected (by December 31, 1984).	
	ISWACO to prepare separate EIA on use of 190 ha of reclaimed land for OOE review.	

TABLE 1 - MUNICIPAL AND INDUSTRIAL DEMAND IN 37 MUNICIPALITIES ON THE NAGDONG RIVER 1/

MUNICIPALITIES & CITIES (Si)	POPULATION FORECAST (1000 PERSONS)					% POPULATION CONNECTED					PER CAPITA PRODUCTION LCD					TOTAL DEMAND 1000 CMD				
	1981	1986	1991	1996	2001	1981	1986	1991	1996	2001	1981	1986	1991	1996	2001	1981	1986	1991	1996	2001
AN DONG (Si)	103	135	180	200	220	89	90	90	92	95	185	250	300	320	350	16.96	30.38	48.60	58.88	73.15
YEONGJU (Si)	82	90	110	120	130	80	85	90	94	95	148	200	250	300	320	9.71	15.30	24.75	33.84	39.52
YEONG YANG	16.4	16.7	17	18	19	50	52	60	70	85	159	160	165	200	220	1.30	1.39	1.68	2.52	3.55
CHEONG SONG	9.9	10	10	10	10	40	47	60	70	85	136	150	150	180	220	0.54	0.71	0.90	1.26	1.87
TOP 4 MUNICIPALITIES	211.3	251.7	317	348	379	80	84	87	91	94	168	226	274	305	331	28.51	47.77	75.93	96.50	118.09
GIM CHEON (Si)	72	85	100	112	121	71	75	80	85	95	203	240	280	300	300	10.38	15.30	22.40	28.56	34.49
JEON CHON	48.6	60.8	77.2	85	92	55	65	80	90	95	137	180	200	240	300	3.66	7.11	12.35	18.36	26.22
SAN JU	54	57	61	66	71	48	65	75	85	90	125	160	180	240	300	3.24	5.93	8.24	13.46	19.17
EUI SEONG	24.4	32	34	36	38	76	70	75	80	95	104	150	180	240	300	1.93	3.36	4.59	6.91	10.83
YE CHEON	26.9	31.3	33.7	35	36	43	44	60	70	85	120	150	180	240	240	1.39	2.07	3.64	5.88	7.34
AN GEI	14	15	15.5	16	17	60	63	70	75	85	140	160	180	200	240	1.18	1.51	1.95	2.40	3.47
GUN WI	12	12	12	12	12	42	49	60	75	85	136	150	180	200	240	0.69	0.88	1.30	1.80	2.45
UPPER 7 MUNICIPALITIES	251.9	293.1	333.4	362	387	58	65	75	83	92	152	189	217	256	291	22.46	36.16	54.47	77.38	103.97
DAE GU (Si)	1838	2270	2630	3020	3366	91	95	97	100	100	209	280	340	400	400	349.57	603.82	867.37	1208.00	1346.40
GU MI (Si)	114	160	200	241	280	66	80	85	90	100	210	250	300	350	400	15.80	32.00	51.00	75.92	112.00
YEONG CHEON (Si)	53	62	69	76	82	80	85	90	95	95	140	200	250	300	300	5.94	10.54	15.53	21.66	23.37
WAE GWAN	29.7	40	50	55	60	81	81	85	90	95	143	180	200	220	240	3.44	5.83	8.50	10.89	13.68
GYEONG SAN	39.8	43.8	48	52	58	48	65	75	85	95	120	160	180	200	240	2.29	4.56	6.48	8.84	13.22
5 MIDDLE MUNICIPALITIES	2074.5	2575.8	2997	3444	3846	88	93	95	99	100	206	274	332	389	393	377.04	656.75	948.88	1325.31	1508.67
JIN JU (Si)	210	260	320	370	413	88	90	95	100	100	210	250	300	340	360	38.81	58.50	91.20	125.80	148.68
GEO CHANG	41	46	52	56	60	61	65	75	80	85	136	150	180	240	240	3.40	4.49	7.02	10.75	12.24
GA YA	18.1	20.4	22.5	24	26	40	50	70	75	85	102	160	180	220	240	0.74	1.63	2.84	3.96	5.30
EUI RYEON	12.5	16.8	19.4	21	23	63	69	75	85	85	140	140	180	220	240	1.10	1.62	2.62	3.93	4.69
HAP CHEON	12.8	14.9	18	20	21	61	66	75	80	85	94	140	160	180	240	0.73	1.38	2.16	2.88	4.28
SAN CHEON	11.9	14.2	16.7	17	18	47	50	60	70	85	90	120	160	180	240	0.50	0.85	1.60	2.14	3.67
GO RYEONG	12.7	12.9	13	13.3	13.8	63	63	75	85	85	143	160	180	240	240	1.14	1.30	1.76	2.71	2.82
7 MIDDLE-LOWER MUNICIPALIT.	319	385.2	461.6	521.3	574.8	77	81	88	94	96	188	225	269	311	330	46.43	69.77	109.19	152.17	181.69
MA SAN (Si)	401	440	490	540	585	80	87	92	95	100	178	260	300	350	400	57.10	99.33	135.24	179.55	234.00
CHANG WON (Si) 2/	128	180	200	220	240	30	80	95	95	100	3176	1141	1404	1400	1400	121.96	164.30	266.76	292.60	336.00
JIN HAE (Si)	114	130	150	160	170	75	85	90	95	95	175	220	250	280	330	14.96	24.31	33.75	42.56	53.30
GIM HAE (Si)	70.7	95	120	130	140	37	50	75	85	95	95	120	180	220	240	2.49	5.70	16.20	24.31	31.92
MIL YANG	47.4	52	55	58	61	58	75	80	85	90	153	200	250	300	300	4.21	7.80	11.00	14.79	16.47
JIN YEONG	22.3	25	26.5	28	29	45	65	80	85	85	118	140	160	200	240	1.18	2.28	3.39	4.76	5.92
CHANG YEONG	23.5	25.3	27	29	30	45	60	70	80	85	152	180	200	240	240	1.61	2.73	3.78	5.57	6.12
CHEONG DO	22.4	23.7	24.9	26	27	44	50	65	75	85	163	180	200	240	240	1.61	2.13	3.24	4.68	5.51
YANG SAN	14	20	22	24	26	57	60	70	80	85	102	140	180	200	240	0.81	1.68	2.77	3.84	5.30
SAMRANG JIN	18.9	19	20.1	21	22	31	34	45	65	85	112	140	160	180	220	0.66	0.90	1.45	2.46	4.11
MA NAN	14.1	15	16.5	17	18	41	43	65	75	85	129	140	160	180	240	0.75	0.90	1.72	2.30	3.67
MUL GEUN	11	12	13	14	15	30	60	75	80	85	80	100	140	180	200	0.44	0.72	1.37	2.02	2.55
LOWER 12 MUNICIPALITIES	887.3	1037	1165	1267	1363	62	77	87	91	97	375	392	475	501	535	207.77	312.99	480.66	579.43	704.87
UL SAN (Si) 2/	451	580	680	750	810	82	85	90	95	100	1000	960	1168	1234	1300	369.82	473.28	714.82	879.23	1053.00
BU SAN (Si)	3249	4188	5140	6010	6850	88	94	98	100	100	267	280	300	360	420	763.39	1102.28	1511.16	2163.60	2793.00
TOTAL 37 MUNICIPALITIES 1/	7444	9311	11094	12702	14010	83	90	94	98	99	294	324	372	426	466	1815.41	2699.00	3895.11	5273.61	6463.29

1/ The total number of municipalities in the Nagdong Basin is 70, including 16 cities (Si), 38 Eubs and 16 Myeons.
2/ Includes the respective special industrial zone.

SECOND WATER SUPPLY PROJECT

TABLE 2 - MUNICIPAL AND INDUSTRIAL WATER DEMAND ON 37 MUNICIPALITIES IN THE NAGDONG RIVER. 1/

YEAR	POPULATION (1000 PERSONS)							WATER DEMAND THOUSAND CMD								
	TOP 4 MUNICIP.	UPPER 7 MUNICIP.	MIDDLE 5 MUNICIP.	MID-LOW MUNICIP.	LOWER 12 MUNICIP.	ULSAN	BUSAN	TOTAL 37 MUNIC	TOP 4 MUNICIP.	UPPER 7 MUNICIP.	MIDDLE 5 MUNICIP.	MID-LOW MUNICIP.	LOWER 12 MUNICIP.	ULSAN	BUSAN	TOTAL FOR 37 MUNICIPALITIES Average	Adjusted 2/	Critical 3/
1981	211	252	2075	319	887	451	3249	7444	28.51	22.46	377.04	46.43	207.77	369.82	763.39	1815.41	1815.41	1906.18
1982	219	260	2166	331	915	474	3418	7784	31.61	24.70	421.30	50.37	225.51	388.52	821.59	1963.60	1869.87	1963.37
1983	227	268	2262	344	944	499	3596	8140	35.05	27.17	470.75	54.65	244.77	408.17	884.23	2124.78	1929.71	2026.20
1984	235	276	2362	357	974	524	3784	8512	38.86	29.89	526.01	59.28	265.67	428.81	951.64	2300.16	1991.46	2091.03
1985	243	284	2467	371	1005	552	3981	8902	43.08	32.88	587.75	64.31	288.36	450.50	1024.20	2491.08	2241.97	2354.07
1986	252	293	2576	385	1037	580	4188	9311	47.77	36.16	656.75	69.77	312.99	473.28	1102.28	2699.00	2564.05	2692.25
1987	264	301	2655	399	1061	599	4363	9642	52.41	39.25	706.90	76.31	341.03	513.96	1174.08	2903.94	2845.86	2988.15
1988	276	309	2737	414	1086	618	4546	9986	57.50	42.60	760.89	83.46	371.58	558.15	1250.55	3124.72	3124.72	3280.96
1989	289	317	2821	429	1112	638	4736	10342	63.08	46.24	819.00	91.28	404.87	606.13	1332.00	3362.60	3362.60	3530.73
1990	303	325	2908	445	1138	659	4934	10711	69.21	50.18	881.55	99.84	441.14	658.23	1418.75	3618.91	3618.91	3799.85
1991	317	333	2997	462	1165	680	5140	11094	75.93	54.47	948.88	109.19	480.66	714.82	1511.16	3895.10	3895.10	4089.86
1992	323	339	3081	473	1185	693	5303	11398	79.66	58.43	1014.45	116.69	498.96	745.03	1623.62	4136.84	4136.84	4343.69
1993	329	345	3168	485	1205	707	5472	11710	83.57	62.68	1084.56	124.70	517.97	776.53	1744.44	4394.44	4394.44	4614.17
1994	335	350	3258	497	1225	721	5646	12032	87.68	67.24	1159.51	133.25	537.69	809.35	1874.26	4668.98	4668.98	4902.43
1995	342	356	3350	509	1246	735	5825	12362	91.98	72.13	1239.64	142.40	558.17	843.57	2013.74	4961.63	4961.63	5209.71
1996	348	362	3444	521	1267	750	6010	12702	96.50	77.38	1325.30	152.17	579.43	879.22	2163.60	5273.61	5273.61	5537.29
1997	354	367	3521	532	1286	762	6133	12953	100.48	82.08	1360.10	157.67	602.59	911.52	2276.96	5491.40	5491.40	5765.97
1998	360	372	3599	542	1305	773	6258	13210	104.62	87.08	1395.81	163.36	626.67	945.00	2396.26	5718.81	5718.81	6004.75
1999	366	377	3680	553	1324	785	6386	13471	108.93	92.38	1432.46	169.25	651.72	979.71	2521.82	5956.27	5956.27	6254.09
2000	373	382	3762	564	1343	798	6517	13738	113.42	98.00	1470.07	175.36	677.78	1015.69	2653.95	6204.27	6204.27	6514.48
2001	379	387	3846	575	1363	810	6650	14010	118.09	103.96	1508.67	181.69	704.87	1053.00	2793.00	6463.29	6463.29	6786.45

1/ The total number of municipalities in the Nagdong Basin is 70, including 16 cities (Si), 38 Eubs and 16 Myeons.

2/ Present demand is rationed, mainly because of lack of water treatment and distribution facilities. The water demand will increase drastically in 1985 and 1986 when the projects under construction by Daegu, Masan, Changweon and Jinhae (financed by the First Water Supply Project) would be completed, as well as similar projects in Busan and other cities.

3/ Water demand is strongly seasonal, with peak demand about 20% over the average. However the peak demand occur in August when the river carries maximum flow. The critical seasonal demand is about 5% over the average (May-June).

ANNEX 3
Table 3

ANNEX 3 - TABLE 3

TABLE 3 -INCREMENTAL MUNICIPAL AND INDUSTRIAL DEMAND IN THE NAGDONG RIVER.

YEAR	TOTAL WATER DEMAND			INCREMENTAL WATER DEMAND FROM 1982 1/ ---REQUIRED --		PROVIDED BY THE BARRAGE:		
	1000 CMD	M3/SEC	MILL.M3/Y	1000 CMD	M3/SEC	1000 CMD	M3/SEC	MILL.M3/Y
1981	1906.18	22.06	695.76	0.00	0.00	0.00	0.00	0.00
1982	1963.37	22.72	716.63	0.00	0.00	0.00	0.00	0.00
1983	2026.20	23.45	739.56	62.83	0.73	0.00	0.00	0.00
1984	2091.03	24.20	763.23	127.67	1.48	0.00	0.00	0.00
1985	2354.07	27.25	859.24	390.71	4.52	0.00	0.00	0.00
1986	2692.25	31.16	982.67	728.88	8.44	0.00	0.00	0.00
1987	2988.15	34.59	1090.68	1024.79	11.86	0.00	0.00	0.00
1988	3280.96	37.97	1197.55	1317.59	15.25	1317.59	15.25	480.92
1989	3530.73	40.86	1288.72	1567.36	18.14	1567.36	18.14	572.09
1990	3799.85	43.98	1386.95	1836.48	21.26	1836.48	21.26	670.32
1991	4089.86	47.34	1492.80	2126.49	24.61	2126.49	24.61	776.17
1992	4343.69	50.27	1585.45	2380.32	27.55	2160.00	25.00	788.40
1993	4614.17	53.40	1684.17	2650.80	30.68	2160.00	25.00	788.40
1994	4902.43	56.74	1789.39	2939.07	34.02	2160.00	25.00	788.40
1995	5209.71	60.30	1901.54	3246.34	37.57	2160.00	25.00	788.40
1996	5537.29	64.09	2021.11	3573.92	41.36	2160.00	25.00	788.40
1997	5765.97	66.74	2104.58	3802.60	44.01	2160.00	25.00	788.40
1998	6004.75	69.50	2191.73	4041.38	46.78	2160.00	25.00	788.40
1999	6254.09	72.39	2282.74	4290.72	49.66	2160.00	25.00	788.40
2000	6514.48	75.40	2377.79	4551.12	52.67	2160.00	25.00	788.40
2001	6786.45	78.55	2477.06	4823.09	55.82	2160.00	25.00	788.40

1/ Given the water shortages and resulting salinity problems in 1982, this year is considered the base year (failure of the present supply).

KOREA

SECOND WATER SUPPLY PROJECT

Project Description

1. The project has three components, which are described below.

A. The Nagdong Barrage

2. The main statistics for the barrage works are given in Table 1. The Nagdong Barrage works (see attached photograph) consist of:

(a) the 511 m long concrete barrage with wingwalls and nine river piers equipped with ten 47.5 m wide radial gates; and a four-lane highway (with provision for extension to six lanes) on a prestressed concrete box girder bridge spanning across the nine barrage river piers and two wing walls. The bridge girders also support the main gates and hoisting gear. Between piers and seated on the river bed is a thick concrete sill protected both upstream and downstream by rock aprons. The whole structure has been designed as a single unit with the piers transmitting the main vertical and longitudinal loads to stable dense sand/gravel foundation layers about 30 m below by means of vertical and raked cylindrical steel piles. The concrete sill, anchored by means of cylindrical steel piles and sheet pile cutoffs, protects the river bed and provides a water seal between the gates and the river bed; it also transmits all lateral loads between wingwalls and piers and anchors the removable steel guides which would hold stop logs isolating each radial gate during cyclical maintenance.

(b) The right bank (west) wing wall of the barrage includes a 9 m wide x 50 m long navigation lock for barges up to 500 dwt, and fish passes designed to facilitate movement of eel and salmon across the barrage.

(c) The main channel on the east branch is dredged to a width varying between 530 m at the barrage to 720 m at the main river confluence 2 km upstream. The river channels adjacent to the barrage sill would be protected by rock aprons, placed on graded granular filters. The downstream end of the rock apron and filter is protected by polyprop filter cloth anchored with gabions. The diversion channel would have an average width of 350 m and would be dredged to -5 SMSL /1 to divert part of the the river flow back

/1 SMSL; Standard Mean Sea Level.

Table 1: MAIN FEATURES OF THE NAGDONG BARRAGE

General Description of the Works	
Catchment area	24,000 sq km
Design discharge	18,300 cu m/s (500 year return period)
Reservoir	
High water level	EL + 1.0 m SMSL (standard mean sea level)
Low water level	EL + 0.5 m SMSL
High flood level	EL + 4.5 m SMSL
Effective storage	50 x million cu m
Barrage and Closure Dam	
Total length	2,400 m
Closure dam & dikes	1,889 m
Barrage	511 m
Barrage gates	All gates: Width 47.5 m x height 8 m Weight 170 tons/gate 6 main radial gates (underflow) 4 regulating radial gates (overflow and underflow)
Discharge sluice	2 vertical roller gates. Width 10 m, height 7 m. (1 spare)
Road bridge	4 lane (18 m) prestressed concrete box girder
Navigation lock	Width 9 m x Length 50 m; 2 sets mitre gates
Land reclamation area	190 ha (formation level : EL + 2 m SMSL)

into the western estuary. The main flood protection levees would be raised 0.5 m, to +6.00 m SMSL upstream and +5.50 m SMSL downstream of the barrage.

(d) The closure dam and dike across Elsukdo Island carrying a four-lane highway (which could later be extended to six lanes), having a crest level of +6.00 m SMSL. All dikes and berms subject to submersion will be protected using ballasting mattresses and dry masonry. The closure dam on the western

river bank will be constructed, after completion of the barrage, using quarry runs dumped from trucks from both banks, and pumping sand against this dumped material. Seabed protection will be provided using polypropylene and rice straw ballasted mattresses, and final closure with rock boulders and pumped sand will be carried out in a single day, under favorable river flow and tide conditions. After river closure is achieved, the dam will be brought up to designed cross sections. A discharge sluice 10 m wide x 7 m high is incorporated in the closure dam.

(e) all ancillary works; road works and viaducts, operations building and service areas and services;

(f) About 190 ha of land reclamation (to about +2.00 m SMSL upstream and downstream of the barrage) will be carried out, partly using suitable dredged materials from the construction pit and partly from dredging of additional suitable materials from selected borrow areas. Precautions will be taken to prevent dredged fines from being deposited in the river channels; most of this material will be transported to disposal areas at sea below the -15 m SMSL contour line. The raising of levels of portions of Elsukdo Island upstream of the barrage (to about +3.00 m SMSL), which will be subject to flooding due to the closure of the west river branch, will also use up some of the unsuitable material. If considered desirable from an ecological viewpoint some of this unsuitable dredged material may also be used to raise bed levels in the west branch river to create new intertidal areas and mud flats.

3. Hydrology. The computation for design floods is based on earlier studies/1 which were reviewed during detailed engineering (1980-82) by NEDECO and ISWACO. The data series from 6 river gauging stations, from 1941-78, was used in the studies. The design flood (T=500 of 18,300 cu m/second) adopted is based on historical water levels and river discharges measured at Jindong station (80 km upstream of barrage site at Hadan), extrapolation of the rating curve, determination of extreme flows at Jindong and estimation of extreme flows at the barrage site.

4. Tide, Wind and Ice Effects. The normal tide levels at the estuary mouth show an average tidal variation of 0.94 m; this is estimated to increase to 1.41 m after barrage construction. Studies have also concluded that no tidal resonance is likely to occur in the estuary and that a possible phase shift of partial tides will only have a minimal influence. Extreme tidal conditions in combination with critical wind speeds have been

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/1 Nagdong River Basin Delta Study (FAO/NEDECO) 1977; Nagdong River Basin Development Project, Feasibility Study 1976 (Nippon Koei Co); Nagdong Basin Study, 1973 (MOC) Regional Flood Frequency in the Nagdong Basin.

estimated to result in critical water level differences of 1.25 m and 3.45 m between the river and the estuary after barrage completion. Critical ice loads for the barrage have been computed, amounting to 0.20 m thickness, based on the analysis of air temperature, wind velocity, cloud cover and freezing periods in Busan.

5. Geology and Foundation Conditions. The estuary is characterized by deep alluvial deposits with rock at -50m SMSL only encountered near the left bank wingwall (Hadandong). A feature of the profile, along the axis of the barrage, is the interbedding of a dense sand/gravel layer at depths of about -30m SMSL by a thick overlay of soft clay with sand pockets and an underlay of stiff clay, and a dense sand layer with gravel and boulders. The stiff clay layer is limited to the barrage site only. Soil investigations included bore holes (maximum depth 60m) with standard penetration tests, field vane shear tests, sampling and field permeability tests. Laboratory work consisted of classification tests, shear and consolidation tests and chemical analysis of soil and water samples. Test pile driving and loading tests will be carried out by the contractor under the supervision of a qualified geophysicist. The overall design, including foundation design, has been reviewed by an Expert Review Panel (ERP) established by ISWACO in consultation with the Bank. Agreement has been reached between the ERP, ISWACO, NEDECO and the Bank on all aspects of final design and specifications, and contract documents and drawings have been modified accordingly.

6. Construction Materials. The major construction materials - cement, quarry materials and steel - are readily available at reasonable costs within the country, except some grades and thicknesses of steel required for the steel piles and gates. Electrical and mechanical gear for gate hoists and navigation locks as well as the lock, radial and sluice gates will be partially imported and manufactured locally under license. Most of the material dredged from the foundation pits and upstream and downstream river channels is unsuitable for use for fills and will be barged and dumped out at sea without affecting the estuary regime. The contract allows for the pilot testing of cyclone separation technology to improve the fills required for land reclamation. The results of this pilot test would be judged on environmental grounds and, if found satisfactory, would be used for part of the land reclamation. Rock required for upstream and downstream protective aprons and the closure dam core is available from commercial quarries in the vicinity of Busan. Sand and other suitable filling materials will be borrowed from identified areas both upriver and from the seabed; the locations of these borrow areas minimize the effect on the river of changes in bottom profiles and sediment load. The project construction will require approximately 23,000 tons of cement, 9,000 tons of reinforcement steel, 10,500 tons of steel piles, 1,850 tons of gate fabrication steel, 900,000 cu m of quarry materials for the closure dam and aprons, 25 million cu m for dredging in foundation pits and approach channels, 2.5 million cu m of suitable fill materials in dikes and the closure dam and 4 million cu m of fill for land reclamation works.

B. National Leak Detection Program.

7. The Local Finance Division in MOHA will implement a national leak detection and control program aimed at conserving water resources and reducing operational costs and capital investments. The project will finance the transfer of appropriate technologies in this field, the implementation of demonstration programs in 15 cities, the purchase of equipment, and the training of key personnel to assist cities in implementing this technology.

8. MOHA have tentatively identified the 15 cities /1 to be included in the program, including four cities with over 500,000 population, five cities with populations betwee 200,000 and 500,000, and six cities with under 200,000 population. All these cities have a reported leakage ratio /2 above 22% and a treated water production over 40,000 CMD. The program will be implemented in two phases.

9. Phase I Program. During Phase I (over the first 6-9 months), MOHA will employ consultants (probably a joint venture between an established local consultant with experience in water distribution and a specialized foreign consultant with experience in leak detection) to carry out, with city staff, basic surveys of each city's distribution network, and identify the priority areas within each network for carrying out leak detection and rehabilitation programs (1984-86). During this initial phase, the consultants will also prepare specifications for additional equipment requirements (to supplement equipment available within each city) and for purchase of modern specialized leak detection equipment developed for this special purpose. During this initial phase, the consultants would also prepare training programs, select key city staff to receive training and start initial traning of staff to apply the methodologies designed to detect and rectify leaks and operate and maintain specialized equipment. It is estimated that 50 key city staff will receive such training over the program period. MOHA will be responsible for hiring of consultants and procurement of equipment in accordance with Bank guidelines.

10. Phase II Program. The second phase of the program, to be implemented over the next two years (until end-1986), would mainly be

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/1 These cities are: Class 1 - Daeju, Incheon, Gwangju, Daejeon; Class 2 - Suweon, Cheonju, Mogpo, Jinju, Cheju; Class 3 - Bucheon, Wonju, Cheongju, Gunsan, Yeosu, Masan.

/2 Unaccounted for water = water produced - water sold. Leakage ratio = (unaccounted for water - estimated unmetered water use)/water produced.

carried out by WB staff with consultant support, identifying and rectifying major leakages and instituting measures to minimize future leakages in their distribution network. Funding requirements for replacement and rehabilitation works will be estimated and with MOHA's support included annually in each city WB budget. Such funds will be specifically earmarked for implementation of this phase of the program.

11. Program Targets. MOHA will, through the consultants, continuously monitor and evaluate the efficiency of design and implementation of the program and be able to adjust the program as necessary to fit conditions in each city. The target for each city is to achieve a reduction in the leakage ratio of 12 percentage points and a reduction in unaccounted for water ratio by 16 percentage points during the program period. These are considered achievable targets, given the high present values of each of these indicators (averaging approximately 27% and 41%, respectively, in the program cities).

12. Costs and Benefits. Annex 5, Table 2 includes a summary of overall costs for this component. These costs are based on expenditures to be incurred on behalf of each city by MOHA and passed on by way of loans. In addition to these costs, each city budget will provide for additional costs of staff, including training, repair and rehabilitation of networks and implementation of preventive measures during 1985/86. During succeeding years, city budgets will provide funds to continue the program and amortize the project loan. Benefits from this program will accrue to each city by way of: awareness by city staff of costs of water wastage, availability of presently wasted water for sale with considerable savings in treatment and distribution costs, and postponement of investments in production capacity. Annex 5, Table 3 gives a tentative breakdown of costs by city and by program components. These allocations will be refined during phase 1 program in consultation with cities.

C. Institutional Development Program

13. A national program will be undertaken to improve accounting and management information for city WBs. This includes the assistance of local and foreign consultants, to prepare basic software for billing, payroll, and storage of general accounting and management information for use with micro-computers and to provide training in implementation of proposed systems to MOHA and selected staff of the WBs. The manuals, software and systems produced will be available to all other WBs in Korea.

14. MOHAs, Local Finance Division, has selected 16 cities, six with more than 50,000 connections each, and ten with between 20,000 and 50,000 connections, to be included in the first stage. A further sixteen cities with 20,000 to 50,000 connections each have been identified for inclusion in a second stage. A third stage, including eleven smaller cities with about 10,000 connections each, has also been identified.

15. This program has been proposed by MOHA given that more than 300 WBs in the country have generally not developed their accounting and financial management sufficiently, to keep pace with expansions in capacity and number of accounts handled. The larger WBs have made a start by introducing computerized billing systems but most cities rely on old manually operated systems and have to hire qualified accountants at the end of each year to close accounts and prepare, as best as possible, end of year balance statements and information. Accounting and billing and preparation of financial management information making revenue projections, etc., during the year is done manually with associated inefficiencies, errors and delays. Furthermore, WBs do not use standardized methods and practices, making it extremely difficult for MOHA to obtain a consolidated picture and compare the relative performance levels and forecast needs of each of these WBs. MOHA has since 1981 studied this problem in detail and has introduced new standardized accounting guidelines, which were reviewed by the Bank, for use by WBs. The program now proposed is the next step in improving their management efficiency.

16. Stage I. MOHA will in the first stage of the program (of about 12 months' duration) employ consultants to work with selected city-staff to make improvements in present accounting methods and practices in accordance with the new guidelines. They will introduce standard procedures and formats to facilitate computerization, identify and test commercially available computer software programs suitable for WB applications, modify such programs and/or write new programs as required for particular applications and assess types and capacities of computer hardware best suited for each city's needs. Consultants will also start a program of training selected key staff (managers and technicians) in computer techniques and system planning and operations (at least four to six persons in each city). These training programs will be of about two weeks duration each, full time, followed by on-site training backed by training manuals to be produced by the consultants.

17. Stage II. In the second stage, (also of about 12 months duration) cities will purchase, through MOHA, recommended computer hardware and introduce computerized systems and software packages with the assistance of the consultants. Staff training and continuous monitoring and evaluation of results will also be a feature of this stage. Experience gained in these cities will assist in smoothening out implementation problems in cities benefitting from subsequent stages of this program.

18. Costs and Benefits. MOHA will employ about 18 manmonths of foreign specialized accounting and computer expertise, and about 85 manmonths of local consultants. These services are estimated to cost W 584 million and will be apportioned to each city on a time sharing basis. Computer equipment is estimated to cost W 500 million (about 32 units). $0.85 million of the Bank loan of $5.0 million to MOHA will be available

to finance this component. Balance fund requirements of about W 420 million will be contributed by the cities. Annex 5, Table 2 shows overall costs of this component. The implementation of this program will introduce greater efficiency in management of WBs with associated benefits for each city. This program is expected to eliminate duplication of efforts and expenses in software and hardware, improve the financial practices of the WBs, produce reliable management information, help improving the sector efficiency and provide a basis for improved management and allocation of resources within the sector.

SECOND WATER SUPPLY PROJECT. ANNEX 5 - TABLE 1

TABLE 1 - NAGDONG BARRAGE - PROJECT COST.

WORKS	---TOTAL IN MILLION WON			------TOTAL IN MILLION US$---			%	%	----------TOTAL COST IN US MILLION---------					
	LOCAL	FOREIGN	TOTAL	LOCAL	FOREIGN	TOTAL	OF TOTAL	FOREIGN	4/1983	1984	1985	1986	1987	2/1988
PREPARATORY WORKS	2130	1316	3446	2.73	1.69	4.42	2.64	38.20	2.87	0.44	0.44	0.44	0.22	0.00
BUILDING PIT	1496	1097	2593	1.92	1.41	3.32	1.99	42.32	0.33	1.66	0.33	0.66	0.33	0.00
EARTH WORKS (EXCL.RECLAMAT)	3568	9117	12685	4.57	11.69	16.26	9.73	71.87	0.00	3.25	3.25	4.88	4.88	0.00
LAND RECLAMATION	888	2267	3155	1.14	2.91	4.04	2.42	71.87	0.00	0.40	1.21	1.21	1.21	0.00
CLOSURE DAM (INCL.PROTECT.)	552	347	899	0.71	0.45	1.15	0.69	38.61	0.00	0.00	0.00	0.46	0.63	0.06
TOTAL EARTH WORKS	6503	12829	19332	8.34	16.45	24.78	14.82	66.36	0.33	5.32	4.80	7.22	7.06	0.06
PROTECTION WORK	4166	4451	8617	5.34	5.71	11.05	6.61	51.65	0.00	2.21	2.21	3.31	2.76	0.55
PILLING	1729	4633	6362	2.22	5.94	8.16	4.88	72.82	1.02	3.67	3.26	0.20	0.00	0.00
PIERS AND WINGWALLS	2680	2138	4818	3.44	2.74	6.18	3.69	44.37	0.00	0.62	3.71	1.85	0.00	0.00
SILLS	909	819	1728	1.16	1.05	2.22	1.33	47.42	0.00	0.00	1.77	0.44	0.00	0.00
BRIDGE WORKS	1140	1114	2254	1.46	1.43	2.89	1.73	49.44	0.00	0.00	2.02	0.87	0.00	0.00
GATES & STRUCTURAL STEEL	1270	3043	4313	1.63	3.90	5.53	3.31	70.54	0.00	0.28	2.21	2.21	0.55	0.28
BARRAGE	7728	11747	19475	9.91	15.06	24.97	14.93	60.32	1.02	4.56	12.98	5.58	0.55	0.28
NAVIGATION LOCK	1020	2442	3462	1.31	3.13	4.44	2.65	70.54	0.00	0.44	0.22	3.11	0.44	0.22
DISCHARGE SLUICE	495	1186	1681	0.63	1.52	2.16	1.29	70.54	0.00	0.22	0.11	1.51	0.22	0.11
OPERATION BUILDING	132	78	210	0.17	0.10	0.27	0.16	37.16	0.00	0.03	0.01	0.19	0.03	0.01
ROAD WORKS	919	465	1384	1.18	0.60	1.77	1.06	33.58	0.00	0.00	0.00	0.00	1.60	0.18
VIADUCTS	318	243	561	0.41	0.31	0.72	0.43	43.35	0.00	0.07	0.04	0.50	0.07	0.04
APPURTENANT WORKS	2884	4414	7298	3.70	5.66	9.36	5.60	60.48	0.00	0.76	0.38	5.31	2.36	0.56
ELECTRIC WORKS	428	496	924	0.55	0.64	1.18	0.71	53.65	0.00	0.00	0.24	0.59	0.24	0.12
MECHANICAL WORKS	1152	3085	4237	1.48	3.96	5.43	3.25	72.82	0.00	0.00	1.09	2.72	1.36	0.27
TOTAL COSTRUCTION WORKS	24991	38338	63329	32.04	49.15	81.19	48.56	60.54	4.22	13.29	22.13	25.17	14.54	1.83
CUSTOM DUTIES & TAXES	6049	0	6049	7.76	0.00	7.76	4.64	0.00	0.78	1.94	1.94	1.55	1.55	0.00
LAND ADQUISITION	6509	0	6509	8.34	0.00	8.34	4.99	0.00	1.67	5.01	1.67	0.00	0.00	0.00
COMPENSATIONS	9022	0	9022	11.57	0.00	11.57	6.92	0.00	1.16	6.94	2.31	1.16	0.00	0.00
LAND AND COMPENSATIONS	15531	0	15531	19.91	0.00	19.91	11.91	0.00	2.83	11.95	3.98	1.16	0.00	0.00
ENVIRONMENTAL MANAGEMENT	570	877	1447	0.73	1.12	1.86	1.11	60.62	0.19	0.37	0.37	0.37	0.37	0.19
PROJECT SUPERVISION	440	2185	2625	0.56	2.80	3.37	2.01	83.23	0.34	0.67	0.67	0.67	0.84	0.17
CONSTRUCTION ADMINISTRATION	6892	0	6892	8.84	0.00	8.84	5.28	0.00	0.44	1.77	2.21	2.21	1.77	0.44
PROJECT MANAGEMENT	7902	3062	10964	10.13	3.93	14.06	8.41	27.93	0.96	2.81	3.25	3.25	2.98	0.80
MICROCOMPUTER HARD. SOFWARE	0.00	76	75	0.00	0.10	0.10	0.06	100.00	0.00	0.10	0.00	0.00	0.00	0.00
BASE COST (SEP 1983 PRICES)	54474	41475	95948	69.84	53.17	123.01	73.57	43.23	8.79	30.09	31.30	31.13	19.08	2.63
PHYSICAL CONTINGENCIES	9682	7372	17054	12.41	9.45	21.86	13.08	43.23	1.56	5.35	5.56	5.53	3.39	0.47
TOTAL CONSTANT PRICE	64156	48847	113002	82.25	62.62	144.87	86.65	43.23	10.35	35.43	36.87	36.66	22.47	3.10
PRICE CONTINGENCIES	8927	8343	17270	11.44	10.70	22.14	13.24	48.31	0.10	2.06	4.97	7.64	6.31	1.05
TOTAL COST	73083	57190	130272	93.70	73.32	167.02	99.89	43.90	10.45	37.50	41.84	44.30	28.78	4.14
BANK FRONT-END FEE		140	140		0.18	0.18	0.11	100.00	0.18					
TOTAL FINANCING REQUIRED	73083	57330	130413	93.70	73.50	167.20	100.00	43.96	10.63	37.50	41.84	44.30	28.78	4.14

ANNEX 5
TABLE 2

S E C O N D W A T E R S U P P L Y P R O J E C T.

NATIONAL PROJECT COMPONENT - PROJECT COST.

	MILLION WON			MILLION $			% OF	%	US $ MILLION			
	LOCAL	FOREIGN	TOTAL	LOCAL	FOREIGN	TOTAL	TOTAL	FOREIGN	1983	1984	1985	1986
LEAK DETECTION CONSULTANTS	1466	1505	2971	1.88	1.93	3.81	48.46	50.66		1.50	1.50	0.81
TRAINING ON LEAKAGE CONTROL	273	172	445	0.35	0.22	0.57	7.25	38.65		0.20	0.20	0.17
LEAK DETECTION EQUIPMENT	0	944	944	0.00	1.21	1.21	15.39	100.00		0.60	0.61	
LEAK DETECTION PROGRAM	1739	2621	4360	2.23	3.36	5.59	71.10	60.11		2.30	2.31	0.98
INSTITUTIONAL IMPROVEMENTS	148	663	811	0.19	0.85	1.04	13.23	81.75		0.20	0.84	
BASE COST (SEP. 1983 PRICES	1887	3284	5171	2.42	4.21	6.63	84.32	63.51		2.50	3.15	0.98
PHYSICAL CONTINGENCIES	187	328	515	0.24	0.42	0.66	8.39	63.69		0.25	0.31	0.10
TOTAL CONSTANT PRICES	2074	3611	5685	2.66	4.63	7.29	92.72	63.52		2.75	3.46	1.08
PRICE CONTINGENCIES	156	281	437	0.20	0.36	0.56	7.12	64.30		0.14	0.35	0.08
TOTAL COST	2230	3892	6122	2.86	4.99	7.85	99.84	63.58		2.89	3.81	1.16
BANK FRONT- END FEE	0	10	10	0.00	0.01	0.01	0.16	100.00	0.01			
TOTAL FINANCING REQUIRED	2230	3902	6132	2.86	5.00	7.86	100.00	63.63	0.01	2.89	3.81	1.16

ANNEX 5
Table 3

KOREA

SECOND WATER SUPPLY PROJECT

Leak Detection Program - Detailed Cost Estimates /a

City	Distribution pipe (km)	Costs: Consultants (basic survey, etc.)	Costs: Training	Costs: Equipment	Total costs: Local	Total costs: Foreign	Total costs: Total
Daegu	4,973	400	60	120	235	345	580
Incheon	3,045	400	50	120	228	342	570
Gwangju	2,597	300	40	90	173	257	430
Daejon	2,144	300	40	90	173	257	430
Suweon	807	220	30	60	128	182	310
Cheonju	1,137	220	30	60	128	182	310
Mogpo	792	220	30	60	128	182	310
Jinjur	804	220	30	60	128	182	310
Jeju	930	220	30	60	128	182	310
Bucheon	480	150	30	60	91	149	240
Wonju	423	150	30	60	92	148	240
Cheongju	541	150	30	60	92	148	240
Gunsan	358	150	30	60	92	148	240
Yeosu	292	510	30	60	92	148	240
Masan	547	150	30	60	92	148	240
Unallocated	-	300	100	200	200	400	600
Total	19,864	3,700	620	1,280	2,200	3,400	5,600

/a Costs based on 1983 prices.

ANNEX 6

KOREA

SECOND WATER SUPPLY PROJECT

Disbursement Schedule
(US$ million)

Bank fiscal year and semester	ISWACO (Nagdong) barrage)	MOHA (national component)	Total	Cumulative disbursements	Project disburse-ment pro-file (%)	Korea's disbursement profile (%)
06/30/84	8.5	0.0	8.5	8.5	10.8	0.7
12/31/84	5.0	1.0	6.0	14.5	18.5	5.2
06/30/85	5.6	1.0	6.6	21.1	26.9	13.6
12/31/85	8.5	1.0	9.5	30.6	39.0	25.7
06/30/86	7.8	1.0	8.8	39.4	50.0	40.2
12/31/86	11.8	1.0	12.8	52.2	66.5	54.9
06/30/87	10.0	-	10.0	62.2	79.2	68.1
12/31/87	9.3	-	9.3	71.5	91.1	78.9
06/30/88	5.0	-	5.0	76.5	97.5	87.1
12/31/88	2.0	-	2.0	78.5	100.0	93.0

SECOND WATER SUPPLY PROJECT

ANNEX 7

TABLE 1 ISWACO - DAMS DIVISION

MILLION WON

INCOME STATEMENT FY ENDS 12/31

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
GENERATED POWER, GWH	988	614	682	682	892	1300	1600	1750	1750	1950
NAGDONG WATER-MILLION M3								481	572	670
OTHER M & I WATER MILL.M3	485	1004	1092	1217	1300	1632	1821	2017	2220	2368
IRRIGATED LAND, HA		87	3200	5500	7200	18868	22206	25807	28481	34953
AVERAGE RATES:										
POWER, WON/KWH	13.86	13.86	18.40	29.12	31.76	35.63	36.16	37.64	40.53	39.73
NAGDONG WATER - WON/M3							0	10	10	11
OTHER M & I WATER WON/M3	1.60	1.91	1.94	2.82	2.80	3.14	3.19	3.32	3.57	3.50
IRRIGATION 1000 WON/HA	0.00	20.88	20.88	28.28	26.20	27.73	26.55	26.08	26.49	24.49
REVENUES - MILLION WON:										
POWER	13694	8510	12549	19862	28326	46319	57851	65874	70926	77470
NAGDONG WATER SALES	0	0	0	0	0	0	0	4613	5814	7219
OTHER M & I WATER SALES	776	1918	2118	3438	3640	5127	5806	6695	7934	8295
IRRIGATION	0	2	67	156	189	523	590	673	754	856
TOTAL OPERATING REVENUES	14470	10430	14734	23456	32155	51969	64247	77855	85428	93840
EXPENSES:										
PERSONNEL	1677	2253	2365	2568	3221	4780	5066	6444	7104	8284
POWER	395	496	521	587	644	707	783	863	915	1067
MATERIALS - MAINTENANCE	458	390	850	925	1035	1262	1338	1588	1683	1963
OTHER DIRECT EXPENSES	529	524	550	591	667	732	782	862	913	1065
ADMINISTRATION-GENERAL	279	411	450	538	633	732	775	890	944	1078
TAXES	285	0	450	500	550	1000	1200	1600	1800	2200
TOTAL OPERATING EXPENSES	3623	4074	5186	5709	6750	9213	9944	12247	13359	15657
INCOME BEFORE DEPRECIATION	10847	6356	9548	17747	25405	42756	54303	65608	72069	78183
DEPRECIATION	6900	7200	7342	7764	11049	16191	20645	25121	27994	30837
OPERATING INCOME	3947	-844	2206	9983	14356	26565	33658	40487	44075	47346
OPERATIONAL INTEREST	2817	2513	2519	2414	5548	8261	10727	12885	15163	14523
NON-OPERATIONAL REVENUES	0	0	0	0	0	0	0	0	0	0
NET INCOME	1130	-3357	-313	7568	8808	18304	22931	27602	28912	32823
RATIOS AND COMPARATORS:										
% WORKING RATIO	25	39	35	24	21	18	15	16	16	17
% OPERATING RATIO	73	108	85	57	55	49	48	48	48	50
% NET INCOME ON REVENUES	8	-32	-2	32	27	35	36	35	34	35
% GROWTH OPERATING REVENUES		-28	41	59	37	62	24	21	10	10
% GROWTH WATER SOLD		107	9	11	7	26	12	37	12	9
% GROWTH POWER SOLD		-38	11	0	31	46	23	9	0	11
AVERAGE RATE BASE	235000	238250	243401	249850	359625	533601	676587	814711	888325	956175
% RATE OF RETURN	1.7	-.3	.9	4	4	5	5	5	5	5

ISWACO - DAMS DIVISION ANNEX 7 - TABLE 2

SOURCES AND APPLICATION OF FUNDS MILLION WON

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SOURCES OF FUNDS										
INCOME BEFORE DEPRECIATION	10847	6356	9548	17747	25405	42756	54303	65608	72069	78183
SALES OF RECLAIMED LAND	0	0	0	0	0	19640	28057	32682	0	0
FUNDS FROM WATER DIVISION			10000	10000	3000					
GROSS INTERNAL GENERATION	10847	6356	19548	27747	28405	62396	82360	98290	72069	78183
NAGDONG-EQUITY CONTRIBUTION				15100	15100	16474				
CHUNGJU	29640	40993	104995	119347	77993	21648				
HAPCHEON		3133	4979	41593	19561	22138				
OTHER EQUITY CONTRIBUTIONS					2400	5000	5000	20000	20000	20000
GOVERMENT EQUITY CONTRIBUT.	29640	44126	109974	176040	115054	65260	5000	20000	20000	20000
BORROWING:										
IBRD- NAGDONG			4040	6560	10975	15304	15062	5390	0	0
IBRD - CHUNGJU	21034	15355	18180	15026	4766	1133	0	0	0	0
OECF - CHUNGJU	32278	12576	5413	6531	2771	1095	0	0	0	0
OECF - HAPCHEON	0	0	4132	20349	32432	16197	0	0	0	0
OTHER LOANS			1963	0	10000	9000	4000	5000	20000	20000
TOTAL BORROWING	53312	27931	33728	48466	60943	42728	19062	10390	20000	20000
TOTAL SOURCES OF FUNDS	93799	78413	163250	252253	204402	170385	106421	128679	112069	118183
APPLICATION OF FUNDS										
CAPITAL EXPENDITURES:										
NAGDONG BARRAGE			8151	29250	32635	34554	22448	3233		
INTEREST CAPITALIZED	2805	4185	3656	8705	8056	7843	7043	4296	1027	1779
CHUNGJU DAM	56921	84296	128272	140432	80353	27135				
HAPCHEON DAM		3133	16794	61790	54447	53090				
OTHER CAPITAL EXPENDITURES	72	72	270	293	4000	8500	38000	70000	70000	80000
TOTAL CAPITAL EXPENDITURES	59798	91686	157143	240470	179492	131122	67491	77529	71027	81779
DEBT SERVICE										
AMORTIZATION	3148	4152	7866	13052	14638	14673	14710	40473	26115	27585
OPERATIONAL INTEREST	2817	2513	2519	2414	5548	8261	10727	12885	15163	14523
TOTAL DEBT SERVICE	5965	6665	10385	15466	20186	22934	25437	53358	41278	42108
WORKING CAPITAL NEEDS (+)	11100	-9906	-1249	-4928	5094	5279	5691	593	1189	-105
TOTAL APPLICATION OF FUNDS	76863	88445	166280	251008	204771	159334	98619	131480	113494	123782
INCREASE (+) OR DECR. CASH		-10032	-3029	1245	-369	11050	7802	-2800	-1425	-5599
DEBT SERVICE RATIO	1.82	0.95	1.88	1.79	1.41	2.72	3.24	1.84	1.75	1.86
% CONTRIBUTION TO INVESTM.	-10.40	10.47	6.63	7.16	1.74	26.07	75.91	57.19	41.68	44.24
% CAPITAL EXPEND /NET ASSET	25	38	64	95	39	22	9	9	8	8

I S W A C O - D A M S D I V I S I O N ANNEX 7 - TABLE 3

BALANCE STATEMENT MILLION WON

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
FIXED ASSETS	256000	265800	278037	297107	521300	678038	851243	1009564	1064080	1220132
ACCUMULATED DEPRECIATION	21000	24300	32735	42709	56449	75688	100420	130964	166030	205833
NET FIXED ASSETS	235000	241500	245302	254398	464851	602350	750823	878600	898050	1014300
WORK IN PROGRESS	86139	151724	308597	548775	404266	335388	212879	144542	215569	137349
CASH	17170	7138	4109	5353	4984	16035	23837	21036	19612	14013
ACCOUNTS RECEIVABLE	1735	1248	1473	2346	3216	5197	6425	7785	8543	9384
INVENTORIES	959	932	979	1052	1126	1372	1454	1696	1798	1906
OTHER CURRENT ASSETS	4570	473	500	538	575	610	646	685	726	770
OTHER ASSETS	55050	73835	73835	73835	198635	276635	333635	370102	370102	434102
TOTAL ASSETS	400623	476850	634795	886296	1077653	1237586	1329699	1424446	1514399	1611822
ACCOUNTS PAYABLE	302	2086	778	856	1013	1382	1492	1837	2004	2349
CONTRACTORS PAYABLE	4633	8144	11000	16833	12564	9179	4724	5427	4972	5725
FUNDS FROM WATER DIVISION	0	0	10000	20000	23000	23000	23000	23000	23000	23000
LONG-TERM DEBT (GROSS)	111326	135105	160967	196381	242686	270742	275093	245010	238895	231310
ASSETS REVALUATION SURPLUS	58088	76163	84689	98494	117442	144972	175919	213042	252715	294484
OPERATIONAL SURPLUS	1130	-2227	-2540	5028	13837	32141	55071	82673	111585	144409
CAPITAL	225144	257579	369901	548703	667111	756171	794400	853456	881228	910546
TOTAL EQUITY	284362	331515	452050	652226	798390	933284	1025390	1149172	1245528	1349438
TOTAL EQUITY & LIABILITIES	400623	476850	634795	886296	1077653	1237586	1329699	1424446	1514399	1611822
WORKING CAPITAL EXCL.CASH	2329	-7577	-8826	-13754	-8661	-3382	2309	2902	4091	3986
% DEBT (DEBT+EQUITY)	28	29	26	23	23	22	21	18	16	15
# DAYS ACCOUNTS RECEIVABLE	44	44	37	37	37	37	37	36	36	36
%DEBT/NET FIX.ASSETS + WIP	35	34	29	24	28	29	29	24	21	20
CURRENT RATIO	4.95	0.96	0.60	0.53	0.73	2.20	5.21	4.30	4.40	3.23

I S W A C O - D A M S D I V I S I O N ANNEX 7 - TABLE 4

MONITORING INDICATORS.

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
DEMAND										
GENERATED POWER, GWH	988	614	682	682	892	1300	1600	1750	1750	1950
% GROWTH POWER SOLD		-37,85	11,07	0,00	30,79	45,74	23,08	9,38	0,00	11,43
NAGDONG WATER-MILLION M3	0	0	0	0	0	0	0	481	572	670
OTHER M & I WATER MILL,M3	485	1004	1092	1217	1300	1632	1821	2017	2220	2368
IRRIGATED LAND, HA	0	87	3200	5500	7200	18868	22206	25807	28481	34953
AVERAGE RATES-CURRENT PRICES										
POWER, WON/KWH	13,86	13,86	18,40	29,12	31,76	35,63	36,16	37,64	40,53	39,73
NAGDONG BARRAGE - WON/M3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	9,59	10,17	10,78
OTHER M & I WATER WON/M3	1,60	1,91	1,94	2,82	2,80	3,14	3,19	3,32	3,57	3,50
IRRIGATION, 1000 WON /HA	0,00	20,88	20,88	28,28	26,20	27,73	26,55	26,08	26,49	24,49
AVERAGE RATES CONSTANT 1983 PRICES & % INCREASES:										
POWER, WON/KWH	18,04	14,87	18,40	27,09	27,61	29,22	27,98	27,48	27,91	25,81
% REAL INCREASE		-17,56	23,72	47,24	1,90	5,85	-4,27	-1,78	1,57	-7,52
OTHER M & I WATER WON/M3	2,08	2,05	1,94	2,63	2,43	2,58	2,47	2,42	2,46	2,28
% REAL INCREASE		-1,59	-5,34	35,45	-7,36	5,85	-4,27	-1,78	1,57	-7,52
FINANCIAL RATIOS										
TOTAL OPERATING REVENUES	14470	10430	14734	23456	32155	51969	64247	77855	85428	93840
% GROWTH OPERATING REVENUES		-28	41	59	37	62	24	21	10	10
% WORKING RATIO	25	39	35	24	21	18	15	16	16	17
% OPERATING RATIO	73	108	85	57	55	49	48	48	48	50
% RATE OF RETURN	1,70	-0,30	0,90	4,00	4,00	5,00	5,00	5,00	5,00	5,00
DEBT SERVICE RATIO	1,82	0,95	1,88	1,79	1,41	2,72	3,24	1,84	1,75	1,86
% CONTRIBUTION TO INVESTM.	-10,40	10,47	6,63	7,16	1,74	26,07	75,91	57,19	41,68	44,24
# DAYS ACCOUNTS RECEIVABLE	44	44	37	37	37	37	37	36	36	36
% DEBT (DEBT+EQUITY)	28	29	26	23	23	22	21	18	16	15

ANNEX 7 -TABLE 5

OVERALL FINANCING PLAN FOR THE DAMS DIVISION MILLION WON

	TOTAL	%	1983	1984	1985	1986	1987	1988
INCOME BEFORE DEPRECIATION	215367	25.24	9548	17747	25405	42756	54303	65608
SALES OF RECLAIMED LAND	80379	9.42	0	0	0	19640	28057	32682
FUNDS FROM WATER DIVISION	23000	2.70	10000	10000	3000	0	0	0
NON-OPERATING REVENUES	0	0.00	0	0	0	0	0	0
GROSS INTERNAL GENERATION	318746	37.36	19548	27747	28405	62396	82360	98290
AMORTIZATION	105412	12.35	7866	13052	14638	14673	14710	40473
OPERATIONAL INTEREST	42354	4.96	2519	2414	5548	8261	10727	12885
TOTAL DEBT SERVICE	147766	17.32	10385	15466	20186	22934	25437	53358
WORKING CAPITAL NEEDS (+)	10479	1.23	-1249	-4928	5094	5279	5691	593
NET INTERNAL GENERATION(+)	160500	18.81	10412	17209	3125	34184	51231	44339
CAPITAL EXPENDITURES:								
NAGDONG BARRAGE	130272	15.27	8151	29250	32635	34554	22448	3233
INTEREST CAPITALIZED	39599	4.64	3656	8705	8056	7843	7043	4296
CHUNGJU DAM	376192	44.09	128272	140432	80353	27135	0	0
HAPCHEON DAM	186121	21.81	16794	61790	54447	53090	0	0
OTHER CAPITAL EXPENDITURES	121063	14.19	270	293	4000	8500	38000	70000
TOTAL CAPITAL EXPENDITURES	853247	100.00	157143	240470	179492	131122	67491	77529
NET TO BE FINANCED (+)	692747	81.19	146732	223261	176366	96938	16260	33190
FINANCED BY:								
IBRD- NAGDONG	57330	6.72	4040	6560	10975	15304	15062	5390
IBRD - CHUNGJU	39105	4.58	18180	15026	4766	1133	0	0
OECF - CHUNGJU	15809	1.85	5413	6531	2771	1095	0	0
OECF - HAPCHEON	73110	8.57	4132	20349	32432	16197	0	0
OTHER LOANS	29963	3.51	1963	0	10000	9000	4000	5000
TOTAL BORROWING	215317	25.24	33728	48466	60943	42728	19062	10390
EQUITY CONTRIB. NAGDONG	46674	5.47	0	15100	15100	16474	0	0
OTHER EQUITY CONTRIBUTIONS	444654	52.11	109974	160940	99954	48786	5000	20000
INCREASE (+) OR DECR. CASH	13898	1.63	-3029	1245	-369	11050	7802	-2800

SECOND WATER SUPPLY PROJECT

ISWACO - WATER DIVISION

INCOME STATEMENT — BILLION WON

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
CONSUMPTION-BILLION M3	0.64	0.92	1.04	1.09	1.15	1.21	1.22	1.31	1.37	1.45
AVERAGE WATER TARIFF / M3	25.40	32.66	31.13	35.53	37.02	39.98	42.15	50.11	59.23	61.70
WATER REVENUES	16.20	30.01	32.34	38.83	42.58	48.37	51.43	65.64	81.15	89.46
OTHER OPERATING REVENUES	1.07	2.09	2.31	2.20	2.35	2.52	2.90	3.10	3.30	3.50
TOTAL OPERATING REVENUES	17.28	32.10	34.65	41.03	44.93	50.89	54.33	68.74	84.45	92.96
WATER LABOR	1.76	2.68	2.81	2.99	3.20	3.41	3.72	4.34	4.97	5.37
POWER	8.86	13.93	16.57	18.52	20.90	23.42	25.03	28.49	31.58	35.43
MATERIALS	0.25	0.34	0.50	0.53	0.57	0.61	0.66	0.77	0.88	0.96
MAINTENANCE	0.58	0.56	0.58	0.62	0.66	0.70	0.76	0.89	1.02	1.10
RAW WATER-PURCHASED	0.82	1.36	1.53	1.64	1.83	1.97	2.11	2.26	2.42	2.59
OTHER	0.41	0.70	0.74	0.78	0.84	0.90	0.98	1.06	1.14	1.22
DIRECT COSTS	12.68	19.57	22.73	25.08	28.00	31.01	33.26	37.80	42.01	46.67
GENERAL EXPENSES	0.32	0.84	0.88	0.97	1.07	1.19	1.27	1.45	1.61	1.81
TAXES	0.22	0.67	0.94	0.90	1.01	1.05	1.10	1.20	1.30	1.70
TOTAL OPERATING EXPENSES	13.22	21.08	24.55	26.95	30.08	33.25	35.63	40.45	44.92	50.18
INCOME BEFORE DEPRECIATION	4.05	11.02	10.10	14.08	14.84	17.64	18.69	28.29	39.53	42.78
DEPRECIATION	2.51	5.55	5.82	6.22	6.67	7.10	7.66	11.38	15.78	17.35
OPERATING INCOME	1.54	5.46	4.28	7.86	8.18	10.54	11.03	16.91	23.75	25.43
OPERATIONAL INTEREST	0.96	1.11	1.80	1.70	1.60	1.49	1.37	1.24	11.06	9.87
OTHER INCOME (+)	0.37	0.68	0.72	0.76	0.81	0.85	0.91	0.96	1.02	1.08
NET INCOME (+)	0.96	5.03	3.20	6.92	7.39	9.90	10.57	16.63	13.71	16.64
AVERAGE RATE BASE	131.56	182.40	189.57	196.59	204.39	210.77	220.67	338.24	475.01	508.70
% WORKING RATIO	76.54	65.68	70.85	65.68	66.96	65.34	65.59	58.85	53.19	53.98
% RATE OF RETURN	1.17	2.99	2.26	4.00	4.00	5.00	5.00	5.00	5.00	5.00
% GROWTH TOTAL REVENUES		85.79	7.94	18.43	9.50	13.28	6.74	26.54	22.85	10.08
% GROWTH OPERATING EXPENSES		59.42	16.44	9.78	11.63	10.54	7.15	13.53	11.04	11.71
OPERATING REVENUES / M3	27.08	34.93	33.35	37.54	39.07	42.06	44.53	52.47	61.64	64.11
OPER.EXPENSES/ M3 CONSUMED	20.73	22.94	23.63	24.66	26.16	27.48	29.21	30.88	32.79	34.61
% TARIFF INCREASE		28.59	-4.69	14.14	4.21	7.98	5.44	18.87	18.21	4.16
TARIFF IN 1983 PRICES	30.80	34.66	31.13	33.44	32.49	32.94	32.77	36.75	40.98	40.27
% REAL TARIFF INCREASES		12.52	-10.19	7.43	-2.83	1.39	-0.53	12.14	11.52	-1.74

ANNEX 8
Table 2

FLOW OF FUNDS BILLION WON

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SOURCES OF FUNDS										
INCOME BEFORE DEPRECIATION	4.05	11.02	10.10	14.08	14.84	17.64	18.69	28.29	39.53	42.78
OTHER INCOME (+)	0.37	0.68	0.72	0.76	0.81	0.85	0.91	0.96	1.02	1.08
GROSS INTERNAL GENERATION	4.42	11.70	10.82	14.84	15.65	18.49	19.60	29.25	40.55	43.86
GRANTS	0.0	0.0	0.0	0.0	15.00	33.00	30.00	25.00	0.0	0.0
INCREASE OTHER LIABILITIES	0.43	0.05	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.04
INCREASE IN RESERVES	0.37	0.39	0.28	0.29	0.31	0.33	0.36	0.42	0.51	0.65
EQUITY INCREASE	69.51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IBRD LOAN	0.96	1.11	1.80	1.70	18.94	24.16	31.73	18.99	1.12	1.06
NATIONAL LOANS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER LOANS	16.82	0.55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL BORROWING	17.78	1.66	1.80	1.70	18.94	24.16	31.73	18.99	1.12	1.06
TOTAL SOURCES	92.51	13.80	12.92	16.86	49.93	76.01	81.73	73.70	42.22	45.61
APPLICATIONS OF FUNDS										
PROJECT INVESTMENT	0.0	0.0	0.0	0.0	53.30	68.03	70.99	47.60	0.0	0.0
CAPITALIZED INTEREST	0.0	0.0	0.0	0.0	1.68	3.78	6.49	8.96	0.0	0.0
METROPOLITAN II	84.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REPLACEMENTS	0.57	0.05	0.50	1.12	1.23	1.36	1.50	1.65	1.70	1.80
OTHER WORKS EXCESS CASH	0.95	1.12	1.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL CAPITAL EXPENDITURES	86.33	1.17	2.30	1.12	56.21	73.17	78.98	58.21	1.70	1.80
AMORTIZATION FOREIGN LOANS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.77	10.77
AMORTIZATION NATIONAL LOANS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AMORTIZATION OTHER LOANS	0.87	1.00	1.00	1.08	1.16	1.25	1.35	1.45	1.56	1.68
TOTAL AMORTIZATION	0.87	1.00	1.00	1.08	1.16	1.25	1.35	1.45	12.33	12.45
OPERATIONAL INTEREST	0.96	1.11	1.80	1.70	1.60	1.49	1.37	1.24	11.06	9.87
TOTAL DEBT SERVICE	1.83	2.11	2.80	2.78	2.76	2.74	2.72	2.69	23.39	22.32
INCREASE IN WORK.CAPITAL	3.63	10.32	-2.01	3.13	-11.87	0.27	0.19	12.80	17.13	21.49
LOAN TO DAMS DIV.	0.0	0.0	10.00	10.00	3.00	0.0	0.0	0.0	0.0	0.0
DEFERRED EXPENSES	0.66	0.19	-0.17	-0.17	-0.17	-0.17	-0.17	0.0	0.0	0.0
OTHER ASSETS	0.06	0.01	0.0	0.00	0.00	0.00	0.01	0.01	0.01	0.01
TOTAL APPLICATIONS	92.51	13.80	12.92	16.86	49.93	76.01	81.73	73.70	42.22	45.61
DEBT SERVICE RATIO	2.42	5.53	3.86	5.34	5.67	6.75	7.21	10.87	1.73	1.97
% CONTRIBUTION TO INVESTMENT	4.48	32.01	524.60	60.69	29.64	22.68	24.08	57.36	83.44	1219.42
% INTERNAL CASH RATIO	1.46	5.13	4.17	5.98	4.86	4.58	3.94	5.44	3.42	4.18
% CAPITAL EXP./GROSS ASSETS	47.18	0.59	1.10	0.50	23.32	28.63	28.19	11.29	0.29	0.29

ANNEX 8
Table 3

BALANCE SHEET — BILLION WON

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
A S S E T S										
FIXED ASSETS IN OPERATION	182.99	197.42	209.59	225.31	241.08	255.54	280.15	515.37	587.99	625.07
ACCUMULATED DEPRECIATION	4.84	10.75	17.11	24.61	33.00	42.08	52.27	66.78	86.57	109.11
NET FIXED ASSETS	178.14	186.67	192.48	200.70	208.08	213.46	227.88	448.59	501.43	515.97
WORK IN PROGRESS	0.0	0.0	0.0	1.12	57.33	130.50	200.21	40.00	0.0	0.0
CASH AND BANKS	6.73	16.03	13.29	16.34	4.18	4.24	5.00	15.89	31.66	52.53
ACCOUNTS RECEIVABLE	1.86	3.06	4.00	4.10	4.49	5.09	5.43	6.87	8.44	9.30
OTHER CURRENT ASSETS	0.07	0.06	0.07	0.07	0.08	0.09	0.0	0.11	0.12	0.14
INVENTORIES	0.22	0.36	0.42	0.56	0.63	0.66	0.0	0.72	0.81	0.95
TOTAL CURRENT ASSETS	8.88	19.51	17.78	21.08	9.39	10.08	10.43	23.60	41.04	62.91
LOAN TO DAMS DIV.	0.0	0.0	10.00	20.00	23.00	23.00	23.00	23.00	23.00	23.00
DEFERRED EXPENSES	0.66	0.85	0.68	0.51	0.34	0.17	0.0	0.0	0.0	0.0
OTHER ASSETS	0.06	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.11
TOTAL ASSETS	187.74	207.10	221.01	243.48	298.21	377.30	461.61	535.29	565.57	601.98
EQUITY AND LIABILITIES										
EQUITY	132.61	132.61	132.61	132.61	132.61	132.61	132.61	132.61	132.61	132.61
CONTRIBUTIONS AND GRANTS	0.0	0.0	0.0	0.0	15.00	48.00	78.00	103.00	103.00	103.00
REVALUATION SURPLUS	32.93	45.84	55.18	69.61	83.66	96.15	108.95	122.63	149.54	179.63
OPERATIONAL SURPLUS	1.46	6.48	9.68	16.61	23.99	33.89	44.46	61.10	74.81	91.45
TOTAL EQUITY	166.99	184.94	197.47	218.83	255.26	310.65	364.03	419.33	459.96	506.69
LONG TERM DEBT(NET)	15.91	16.57	17.29	17.83	35.52	58.32	88.60	95.27	83.94	72.54
ACCOUNTS PAYABLE	0.92	1.23	1.51	1.68	1.86	2.29	2.45	2.82	3.13	3.51
CURRENT MATURITIES	1.00	1.00	1.08	1.16	1.25	1.35	1.45	12.33	12.45	12.47
TOTAL CURRENT LIABILITIES	1.92	2.23	2.59	2.84	3.11	3.64	3.90	15.15	15.58	15.98
OTHER LIABILITIES	0.43	0.48	0.50	0.53	0.56	0.60	0.63	0.67	0.71	0.75
RESERVES	2.29	2.68	2.96	3.25	3.56	3.89	4.25	4.67	5.18	5.83
TOTAL LIABILITIES	20.55	21.96	23.34	24.45	42.75	66.45	97.38	115.75	105.41	95.09
TOTAL EQUITY-LIABILITIES	187.54	206.90	220.81	243.28	298.01	377.10	461.41	535.09	565.37	601.78
NO.DAYS ACCOUNTS RECEIVABLE	39	34	42	36	36	36	36	36	36	36
%DEBT/(NET ASSETS + WIP)	8.93	8.88	8.98	8.83	13.38	16.96	20.70	19.50	16.74	14.06
WORKING CAPITAL-MILLION	7.96	18.28	16.27	19.40	7.53	7.79	7.98	20.78	37.91	59.40
CURRENT RATIO	4.63	8.75	6.86	7.42	3.02	2.77	2.67	1.56	2.63	3.94
% DEBT/(DEBT+EQUITY)	8.70	8.22	8.05	7.53	12.21	15.81	19.57	18.51	15.43	12.52

KOREA

SECOND WATER SUPPLY PROJECT

ISWACO - Water Division

Monitoring Indicators

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Demand										
Consumption (bln cu m)	0.64	0.92	1.04	1.09	1.15	1.21	1.22	1.31	1.37	1.45
% unaccounted for water	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Production (bln cu m)	0.67	0.97	1.09	1.15	1.21	1.27	1.28	1.38	1.44	1.53
% used of capacity	43.6	62.8	68.8	72.4	71.2	74.9	75.5	62.7	65.6	69.4
Administration										
% personnel cost on total	13.3	12.7	11.5	11.1	10.6	10.3	10.5	10.7	11.1	10.7
Costs										
Exchange rate US$1 =	710	730	760	780	780	780	780	780	780	780
Operating cost (W mln)	13.2	21.1	24.6	27.0	30.1	33.3	35.6	40.5	44.9	50.2
Cost US$/cu m sold	0.030	0.030	0.030	0.032	0.034	0.035	0.037	0.040	0.042	0.044
Local inflation (%)	21.30	7.25	5.00	7.50	7.00	6.00	6.00	6.00	6.00	6.00
Revenues										
Operating revenues (W bln)	17.3	32.1	34.7	40.8	44.6	50.5	54.0	68.3	84.0	92.5
Average tariff (W/cu m sold)	25	32	31	35	37	40	42	50	59	61
Average tariff (US$/cu m sold)	0.036	0.045	0.040	0.045	0.047	0.051	0.054	0.064	0.076	0.079
Analysis in Constant (1983) Prices										
Average tariff (W/cu m)	27.9	34.6	31.1	33.2	32.3	32.7	32.5	36.5	40.8	40.1
% rate increase	0	24	-10	7	3	1	-1	12	12	-2
Personnel costs	2.8	2.8	2.8	2.8	2.8	2.8	2.9	3.2	3.4	3.5
% increase personnel costs	0	0	0	0	0	0	3	10	8	2
Financial Ratios										
% rate of return	1.2	3.0	2.3	4.0	4.0	5.0	5.0	5.0	5.0	5.0
% working ratio	77	66	71	66	67	66	66	59	54	54
% receivables in biling	11	10	12	10	10	10	10	10	10	10

ANNEX 9
Table 1

KOREA

SECOND WATER SUPPLY PROJECT

ISWACO Consolidated Financial Statements

Income Statement
(Million won)

	1980	1981	1982
Operating revenue			
Water supply	12,232	19,423	32,099
Dams	6,912	15,189	11,030
Industrial sites, New cities	60,890	35,931	28,823
Others	24,530	5,008	1,132
Total revenue	104,564	75,551	73,084
Operating expenses (a)			
Water supply	11,094	18,402	24,943
Dams	6,325	11,752	12,692
Industrial sites, New cities	60,771	35,947	28,823
Others	23,762	4,477	1,264
Total expenses	101,952	70,578	67,722
Gross income	2,612	4,973	5,362
General administration	2,469	2,880	3,647
Operating income	143	2,093	1,715
Non-operating income(expense)			
Interest income	2,963	3,813	4,096
Amortization of exchange losses	(216)	(997)	(940)
Other-net	1,183	1,662	779
Sub-total	3,930	4,478	3,935
Income befor income taxes	4,073	6,571	5,650
Income taxes	445	742	806
Net Income	3,628	5,829	4,844

Source : Audit report

(a) Includes depreciation and operational interest.

KOREA

SECOND WATER SUPPLY PROJECT

ISWACO Consolidated Financial Statements

Balance Statement
(Million won)

Assets	1980	1981	1982
Fixed Assets			
Dam division	77,187	191,447	184,835
Accum. depreciation	(12,072)	(14,535)	(19,498)
Water Supply division	63,286	148,074	148,219
Accum. depreciation	(1,528)	(4,160)	(8,429)
Operating facilities-other div.-net	7,817	16,773	4,199
Net	134,690	337,599	309,326
Construction in progress	32,619	84,792	169,231
Sub-total	167,309	422,391	478,557
Deferred charges	16,378	17,732	19,372
Other assets	190,400	187,003	180,767
Current assets			
Cash	5,056	17,212	8,617
Accounts receivable	5,489	5,982	9,269
Inventories	842	1,268	2,110
Others	15,428	11,953	26,776
Sub-total	26,815	36,415	46,772
Total Assets	400,902	663,541	725,468
Long-term Liabilities			
Local loans	66,288	56,628	45,411
Foreign loan	53,028	126,241	137,089
Employees' severance indemnities	5,025	6,476	8,651
Others	78,533	163,209	151,355
Sub-total	202,874	352,554	342,506
Current liabilities			
Accounts payable	11,158	7,607	6,694
Short-term borrowing	6,100	10,849	12,800
Current maturities of long term loans	16,268	23,889	20,598
Others	7,864	6,336	14,172
Sub-total	41,390	48,681	54,264
Total liabilities	244,264	401,235	396,770
Equity			
Capital	120,383	219,383	280,182
Revaluation surplus	25,617	25,663	25,663
Other surplus	171	211	211
Retained earning	10,467	17,049	22,642
Total equity	156,638	262,306	328,698
Total Liabilities and Equity	400,902	663,541	725,468

Source : Audit report

KOREA

SECOND WATER SUPPLY PROJECT

Economic Analysis

Failure of the Nagdong River Basin System

1. The failure of the Nagdong River Basin system is reached when excessive salinity /1 pollutes the downstream reach and interferes with water abstraction from the river. This is especially important for (a) the agricultural water intake (22 km from the river mouth) of the agricultural Gimhae polder, the largest single irrigation area and one of the most productive agricultural zones in Korea; and (b) the water intake for Busan (Mulgeum) and Ulsan/Onsan (27 and 29 km from the river mouth). These two cities represent half (4.1 million) of the total population, and almost 60% of the estimated demand of 37 cities and towns in the Nagdong Basin (Annex 3). These two cities service an important part of the industrial production of the basin which represents 40% of the country's total, with 7,000 industries located in Busan alone. In 1976 FAO/NEDECO estimated that Andong Dam would be able to supply the water demand without excessive salinity levels until 1989 under the 1967/68 drought conditions. The NEDECO study in 1981 forecasted that the failure year would be reached earlier, by 1984. However, salinity levels in excess of 5 to 10 times permissible salinity standards have been recorded at Busan since 1977. This required stopping water pumping for 373 hours in 1977, 178 hours in 1978 and 274 hours in 1981 (even abstracting at salinity levels of 500 ppm). 1982 has been the worst year, with high salinity levels not only during the dry season (winter) but also during the month of June. As a result daily stopping of pumping took place at Busan and Ulsan during almost two months between January and March and again in June. This serious problem was analyzed in NEDECO's updated Nagdong report, May 1983, concluding that 1982 should be considered the failure year: any city using additional upstream water after 1982 would only exacerbate the problems of downstream users. This conclusion is used in the assignment of water charges (para. 9).

2. Recent data show that even with flows of 60 cu m/s at Jindong (the lowest gauging station, 80 km from the river mouth, where flow measurements are independent of tidal variations), recorded salinity levels exceed 2,000 ppm at the Busan intake. This is about 10 times the salinity level forecasted by simplified one-dimensional salinity models. Salinity levels depend on the complex interaction of many variables (flow and withdrawals,

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/1 Korea's standard for drinking and industrial water supply specifies maximum salinity (chloride) levels of 150 ppm. For the analysis of alternatives, maximum salinity levels of 300 ppm were allowed for municipal water and 1,200 ppm for agricultural water.

ANNEX 10
TABLE 1

K O R E A

S E C O N D W A T E R S U P P L Y P R O J E C T

A L T E R N A T I V E C O S T O F W A T E R

UPSTREAM RELOCATION OF THE WATER INTAKES OF BUSAN AND ULSAN AND THE GIMHAE AGRICULTURAL AREA

CONSTRUCTION AND OPERATING EXPENSES — MILLION WON 1983 PRICES

		BUSAN			ULSAN / ONSAN		TOTALS		
	YEAR	MULGEUM INTAKE	MAERI	EXTENSION	PRESENT INTAKE	EXTENSION	M & I WATER	AGRIC. WATER	TOTAL
CRF	CAPACITY								
4,09	CMD	850000	500000	500000	500000	300000	2650000	1300000	3950000
	DISTANCE KM	13	11	11	11	11		12	
	1983						0	0	0
	1984						0	0	0
	1985						0	0	0
	1986	11730	4845		9095		25670	23715	49385
	1987	11730	4845		9095		25670	23715	49385
	1988	920	350	4845	350	7072	13537	1110	14647
	1989	920	350	4845	350	7072	13537	1110	14647
	1990	920	350	350	350	410	2380	1110	3490
	1991	920	350	350	350	410	2380	1110	3490
	1992	920	350	350	350	410	2380	1110	3490
	1993-2028	920	350	350	350	410	2380	1110	1110
	PRESENT VALUES AT 10%	22970	9287	7666	15383	10636	65941	41429	97636

depth, geometry, currents, tidal amplitude, winds, etc.). Salinity intrusion depends particularly on water depth (to the cubic power) which is easily affected by storms and floods. Salinity records at Mulgeum indicate that the flow requirements to maintain acceptable salinity levels for the downstream users, under the forecasted demand, are of such an order of magnitude that they cannot reliably be met by additional water releases from upstream dams. This applies to Hapcheon Dam (17 cu m/s) which was originally considered an alternative to the barrage but is now being built and justified on the basis of electric power generation only. Locations for dams in the river basin are scarce and any dam would reduce critical agricultural areas. However, even if upstream dams could solve present salinity problems and provide sufficient water to meet the additional water demand, using this volume of water (enough to supply 10 million persons) for salinity repulsion is a waste of a scarce resource. The barrage would eliminate existing supply and salinity problems and would allow the use of about 25 cu m/s, presently being wasted to control salinity, for 37 cities and towns depending on the river for their water supply. A minimum flow of about 15 cu m/s would be maintained to allow for minimum dilution, navigation, and fisheries requirements and to provide nutrients to the estuary area.

Least-Cost Solution

3. As explained in SAR para. 6.03, the barrage has been identified as the least-cost solution for these problems in many studies dating back to 1972. In addition to upstream dams, the feasibility study analyzed the construction of water storage facilities in the cities (which would provide water during the critical period). This alternative requires large areas of land (already a critical factor in many cities) and costly changes in the water conveyance systems. Another alternative studied was resiting upstream of water intakes for Gimhae, Busan and Ulsan. A minimum resiting of the water intake (11 km upstream of present locations) was considered for the alternative cost of water (para. 4) and the project ERR. These alternatives are, however, not fully comparable. For example, the Gimhae agricultural polder area, with the barrage, would be bordered by fresh instead of highly saline water, minimizing salt water infiltration. Furthermore, the barrage would provide practically saline-free water, whereas other alternatives would only maintain salinity levels below a maximum limit.

Alternative Cost of Water Supply

4. The alternative cost of water supply was estimated based on the cost of relocating the water intakes of the cities of Busan and Ulsan/Onsan, and the Gimhae agricultural area to an upstream location. At such a location, salinity should be below allowable international standards (300 ppm for municipal and 1200 ppm for agricultural water) under mean spring tidal conditions. As a result of increasing demand, the water available in the river after abstractions would be around 15 cu m/s by 1992.

KOREA

SECOND WATER SUPPLY PROJECT

ANNEX 10
TABLE 2

NAGDONG BARRAGE - SEPARABLE COSTS (A), ALTERNATIVE COST (B), AND BENEFITS (C) OF THE PROJECT

MILLION WON, 1983 PRICES

	NAGDONG BARRAGE COST		A)---SEPARABLE COSTS ---			C) BENEFIT	A)SEPARABLE COST	B) Alter	---C) BENEFITS -----			B) Alter	C) BENEFIT		C) BENEFIT		WATER
YEAR	INVEST-MENT (1)	O & M cost	Dredging	Dikes	Infra-struct.2/	Sales Reclaimed land 3/	Viaducts	Roads 4/	bridge cost 5/	Distance 6/	Congest. 7/	Land apprecia- 8/	Intake Cost 9/	Add.drain-age cost 10/	11/	Peak gener.GWH 12/	Price W/kWh 13/	Intake reloca tion 14/
1983	7341																	
1984	25708		367	616			64											
1985	26908		1109	810			37											
1986	27073		1109	823	3838	24566	46	2093					23715					25670
1987	16066		1109		3838	24566	64	2093	5950				23715	7225				25670
1988	2410	375			3838	24566	37		5950	855	54	13636	1110	7225	1215	28	26	725	13537
1989		750								908	55		1110	8500	2498	30	26	785	13537
1990		750								960	56		1110		3858	30	26	793	2380
1991		750								960	56		1110		5298	29	27	774	2380
1992		750								960	56		1110		6820	28	27	755	2380
1993		750								960	56		1110		6820	28	27	762	2380
1994		750								960	56		1110		6820	28	27	770	2380
1995		750								960	56		1110		6820	28	27	756	2380
1996-2018		750								960	56		1110		6820	28	27	756	2380
PRESENT VALUES AT 10% DISCOUNT RATE:																			
	85761	4777	2840	1848	7889	50489	190	3002	7758	6318	372	8467	41429	14219	37402			5080	65941

1/ Project cost excluding microcomputers and taxes but including physical contingencies.
2/ Roads, electricity and sewerage infrastructure, W 28600 per piong.
3/ Sales of reclaimed land at W 128,000/piong.
4/ Additional road link through polder area (not included in the project), deducted from benefits.
5/ Alternative cost of a separate bridge at the barrage location.
6/ Due to reduced travel distance particularly to Busan-harbour.
7/ Reduced congestion in the other 3 bridges by (1988).
8/ Land appreciation in the right bank side estimated at W 10000 per piong, (8% of the value at the left bank) for 2% (450 ha) of the polder area closer to the barrage.
9/ Cost of transferring the water intake 12 km uptream to avoid salinities in excess of 1200 ppm.
10/ Additional drainage cost to allow intensive irrigation.
11/ Based on farmgate price of farm products. Economic prices estimated at 80% of the financial prices.
12/ Additional peak generation made feasible in Andong Dam.
13/ Coal and oil saved (W 25.9 per KWH) at Andong Dam, since an smaller continuous flow would be needed after the Barrage is completed.
14/ Alternative cost of relocating the existing intakes of Busan, Ulsan/Onsan 11-13 km upstream to avoid salinity levels in excess of 300 ppm.

SOURCE: NEDECO'S NAGDONG ESTUARY BARRAGE UPDATE MAY 1983 AND APPRAISAL ESTIMATES.

This low flow would have a more than proportional effect on salinity (because of much lower dilution capacity, velocity and inertia forces). With flows as low as 15 cu m/s, salinity levels are expected to increase 2.8 times (Project File reference 3). The alternative location of the water intakes was estimated to be 9-10 km upstream of their present location, based on salinity profiles constructed for the river with 15 cu m/s flow and mean spring tide conditions. However, since the river bed shows an average difference of less than 0.5 meters between Busan's present intake and the new estimated locations and there is a sharp rise in the elevation of the river bed (3.5 meters) in the next few kilometers, the analysis of the alternative cost of water assumes the relocation of the water intake to this point, located in km 40, only 11 km and 13 km upstream from present Ulsan and Busan water intakes (Table 1).

5. The alternative investment costs are phased in such a way as to either enter into operation at the same time as the barrage or when future expansions are needed. Construction costs were calculated based on actual prices for similar works, reduced 15% due to the present reduction of construction costs. Operational expenses (power) assume that the resited intakes would be used only six months per year for water supply and three months per year for agriculture. Present intakes would be used during the rest of the year. No further extensions are added after 1992, when the incremental demand in the river basin reaches the limit (25 cu m/s) of water made available by the barrage (Annex 3).

Project Cost and Benefits

6. The project multipurpose benefits are described in paras. 6.04-6.08. The cost allocation follows the "separable cost, remaining benefits method" as shown in Table 3. The project cost, benefits, separable and alternative cost of each component are shown in Table 2. The project cost for economic analysis excludes taxes and duties, and the cost of microcomputer hardware. The main benefit, water supply, is estimated as the saving in the alternative cost of transferring the intakes. This is conservative, since other estimates (like the cost of failure of the domestic and industrial supply and alternative storage) yield higher values. The feasibility study analyzed in detail the situation with and without the barrage and the increased agriculture yield achievable with a reliable fresh water supply; some of the agricultural benefits are achieved directly; others require some drainage improvements, the costs of which have been deducted from the benefits. The bridge function has the separable cost of viaducts and roads. Its alternative cost (Table 2) is a bridge at a similar location, the cost of which is about 64% of the expected benefits. These benefits include the reduction in distance and avoidance of traffic congestion toward Jinhae and the airport. Land is scarce and valuable in Busan. The vicinity near downtown and easy access to Busan resulting from the barrage would allow some areas of the polder to be urbanized in the medium term (by 1988). Conservatively a reduced area (450 ha, 2% of the polder in the right bank) is assumed to appreciate in value by W 10,000/pyong (8% of the estimated land value at the left bank). With the announcement of the Government decision to build the barrage, the land near

ANNEX 10
TABLE 3

ALLOCATION OF THE COST OF THE NAGDONG BARRAGE TO EACH PURPOSE

PRESENT VALUES AT 10 % DISCOUNT RATE - MILLION WON 1983 PRICES

	TOTAL	LAND RECLA-MATION	BRIDGE FUNCTION	AGRI-CULTURE	POWER	WATER SUPPLY
A) BENEFITS OF PURPOSE	148959	42600	12155	23183	5080	65941
B) ALTERNATIVE COST OF COMPONENT	162809	42600	7758	41429	5080	65941
C) JUSTIFIABLE EXPENDITURE	144563	42600	7758	23183	5080	65941
D) SEPARABLE COST OF COMPONENT	4878	4688	190	0	0	0
E) REMAINING JUSTIFIABLE EXPEND.	139685	37912	7569	23183	5080	65941
F) % DISTRIBUTION	100.00	27.14	5.42	16.60	3.64	47.21
G) REMAINING JOINT COST	85660	23249	4641	14217	3115	40437
H) TOTAL ALLOCATED COST	90538	27937	4831	14217	3115	40437
I) TOTAL COST ALLOCATION %	100.00	30.86	5.34	15.70	3.44	44.66

MARGINAL COST OF WATER

ANNEX 10
TABLE 4

YEAR	NAGDONG BARRAGE TOTAL COST	SHARE FOR WATER SUPPL 44.66	INCREMENTAL WATER USED MILLION M3/YEAR
1983	7341	3279	
1984	25708	11482	
1985	26908	12018	
1986	27073	12092	
1987	16066	7176	
1988	2785	1244	481.18
1989	750	335	572.37
1990	750	335	670.63
1991	750	335	775.47
1992	750	335	788.40
1993	750	335	788.40
1994	750	335	788.40
1995	750	335	788.40
1996-2018	750	335	788.40
PV AT 10%	89398	40437	4886.73

MARGINAL COST WON PER CUBIC METER OF WATER

DISCOUNT RATE %	PRESENT VALUES		MARGINAL COST	
	COST	VOLUME	WON/M3	W/1000 CMD
10	40437	4887	8.27	22.67
8	42642	6489	6.57	18.00
5	46905	10635	4.41	12.08

the barrage on the left bank has already reached values between 130,000 and 1,000,000 W/pyong (about $172 to $400/sq m).

7. Power benefits result from the capacity to use Andong Dam water (926 million cu m) as needed to generate peak power, without the constraint of a continuous minimum average flow. This saves energy, presently used during off-peak hours to pump-back from the after-bay weir to the main reservoir.

8. For land reclamation the alternative costs and benefits are assumed the same. This provides some cross-subsidization for water supply. There is no other available land with so extremely favorable a location (bordering Busan's main areas, with all public services) which could be used for alternative analysis. Furthermore, without the barrage and the channel dredging associated with the barrage works (which provide part of the filling material) and the construction of new protection works, this separate component may not be feasible. This, and the difficulty of allocating the separate cost of many general components, (taxes, compensations, engineering, etc.) explains the large difference between the benefits and separable costs of this component. About 30% of the reclaimed land would be used for roads, parks and public services. The remaining land, net of the cost of main infrastructure, has a value estimated today at W 160,000/pyong (for the net area) or about W 128,000/pyong for the total area. Given the scarcity of land in Busan, the real price of land is expected to continue rising by the time the land reclamation is completed (1987), but this increased value has not been included in the analysis.

Cost Recovery - Marginal Cost

9. As explained in para 6.10, the cost of water supply, land reclamation and power (79%) would be recovered through ISWACO charges. The traffic, land appreciation and agricultural benefits (21%) are to be recovered by Government established taxes. The cost of water would be recovered through water charges close to the marginal cost. The marginal cost is estimated between W 6.5 and W 8.3/cu m for discount rates between 8-10% (Table 4). To assess future water charges, consideration should be given to the social and political impact of large increases over the present low charges for Andong Dam water (W 2.7/cu m), and the difficulty of collecting water charges from a river subject to wide seasonal fluctuations. Agreement has been reached that water would be charged at the marginal cost using a discount rate acceptable to the Bank (para. 6.10). This would provide ISWACO with a satisfactory financial rate of return.

Economic Rate of Return (ERR)

10. The ERR is estimated at 24% (Table 5). This is conservative since some of the water supply benefits (like the improvement of living standards and the provision of saline-free water) are difficult to quantify and have not been included in the analysis. The sensitivity analysis and switching factors in Table 5 and para. 6.11 show that the project would be justified even under extreme assumptions.

ANNEX 10
TABLE 5

K O R E A

S E C O N D W A T E R S U P P L Y P R O J E C T

ECONOMIC RATE OF RETURN (ERR) OF THE NAGDONG BARRAGE

MILLION WON 1983 PRICES

YEAR	PROJECT COST	NET BENEFITS: LAND RECLAMATION	BRIDGE	AGRICULTURE	POWER	WATER SUPPLY	TOTAL PROJECT BENEFITS	NET CASH
1983	7341	0	0	0	0	0	0	-7341
1984	25708	0	0	0	0	0	0	-25708
1985	26908	0	0	0	0	0	0	-26908
1986	27073	20727	-2093	0	0	25670	44304	17231
1987	16066	20727	-2093	-7225	0	25670	37079	21013
1988	2785	20727	14545	-6010	725	13537	43524	40739
1989	750	0	963	-6002	785	13537	9283	8533
1990	750	0	1016	3858	793	2380	8047	7297
1991	750	0	1016	5298	774	2380	9468	8718
1992	750	0	1016	6820	755	2380	10971	10221
1993	750	0	1016	6820	762	2380	10978	10228
1994	750	0	1016	6820	770	2380	10986	10236
1995	750	0	1016	6820	756	2380	10972	10222
1996-2018	750	0	1016	6820	756	2380	10972	10222
PV AT 10%	90538	42600	12155	23183	5080	65941	148959	58422

THE ECONOMIC RATE OF RETURN (ERR) IS: 23.7 %

SENSITIVITY ANALYSIS:	% ERR
A) WATER SUPPLY BENEFITS REDUCED 10%	21.70
B) AGRICULTURAL BENEFITS EXCLUDED	23.50
C) LAND RECLAMATION BENEFIT EXCLUDED	12.40
C) TWO YEARS COMPLETION DELAY	15.20

SWITCHING VALUES: (% REDUCTION IN BENEFITS STILL ACHIEVING 10% ERR)

WATER SUPPLY	89
LAND RECLAMATION	137
AGRICULTURE, BRIDGE, POWER	145

1/ SOURCE: NEDECO'S NAGDONG ESTUARY BARRAGE UPDATE (MAY 1983) AND APPRAISAL ESTIMATES.

KOREA

SECOND WATER SUPPLY PROJECT

Assumptions for Financial Projections

Inflation

1. Local price contingencies assume that Korea's inflation will be 5% in 1983, 7.5% in 1984, 7% in 1985 and 6% p.a. thereafter. The expected price contingencies for foreign costs are estimated at 8% for 1983, 7.5% for 1984, 7% for 1985 and 6% p.a. thereafter. The exchange rate is assumed at W780 per dollar.

Taxes

2. ISWACO was previously exempted from income taxes but is now required to pay income and defense taxes at a rate of about 11% of its net income before taxes. Provisions for income taxes have been included in the financial projections for each division.

Assets Revaluation

3. Korean regulations allow for the revaluation of fixed assets when their estimated value exceeds the book value by 25% or more. The revaluation is detailed and requires the approval of Government auditors. ISWACO has not revalued its fixed assets since 1977. This results in low rates and tariffs (since the depreciation and average net assets used to compute the rate of return are underestimated) and the payment of more taxes than necessary. The revaluation of some assets is expected to exceed 200%. The financial projections include the estimated revalued fixed assets, and maintain the fixed assets revalued thereafter, using 85% of the increases in the wholesale price index as a conservative proxy for the price increase of capital goods.

Water and Dams Divisions

4. These divisions are the only income generating Divisions in ISWACO. The Industrial sites just recover the respective direct expenditures. Operational revenues in the financial projections include sales of water and power, and the collection of charges from municipalities or industries using water from rivers regulated by ISWACO's dams. Incidental revenues (as land sales) are not included. The expenses include the allocation of general administration, taxes, operational interest, and the estimated revalued depreciation. This explains the difference in 1981-82 between these projections and the cost breakdown shown in Table 5.2.

A. Water Division

5. The Water Division owns and operates bulk water production and transmission facilities built by MOC. ISWACO provides bulk raw water to eight regional projects including the Metropolian area of Seoul. ISWACO

also provides treated water to industrial areas and some cities adjacent to them. Financial projections for this division take into account the forecasted Third Stage Project for the Metropolitan area, whose feasibility study has been completed and is expected to be built between 1985 and 1988.

Water Demand - Tariffs

6. The analysis of the raw and treated water demand is available in the project files. The water demand is projected in accordance with the categories in the present tariff structure. Unaccounted-for water is assumed at 5% since only bulk pipelines are included and water is metered at the receiving end of treatment plants. ISWACO's tariffs for raw and treated water are satisfactory and include fixed charges for the basic contracted water capacity, metered charges varying with the volume used and surcharges for the volume used in excess of the contracted supply. ISWACO's water tariffs were increased 100% in the Metropolitan Seoul area during the years 1980 and 1981. Future tariff increases are as needed to achieve the covenanted rates of return on revalued assets (4% in 1984-85, 5% thereafter). The Third Metropolitan Stage is expensive, with a marginal cost of about W 80/cu m (compared with W 30/cu m now). Achievement of the covenanted rate of return requires tariff increases of 31% in real terms between 1983-89.

Expenses

7. Power expenses represent 68% of the total, and include a fixed charge, depending on installed capacity (which remains constant until the capacity is expanded) and charges per kWh used, which are projected in proportion to the volume produced. Personnel expenses have been projected constant (in real prices) until the Third Stage enters into operation, when about 10% more staff would be needed. Materials and maintenance are projected on the basis of historical expenses and trends. Other expenses are projected in proportion to the volume of raw water produced, which represents 97% of the water sold. Central administrative expenses are allocated in proportion to the direct expenses of each division.

Debt Service

8. The debt service is mainly with ADB (US$22.2 million payable in 24 years at 7.5%), which financed the First Stage Metropolitan Project.

Cash Flow

9. The Third Metropolitan Stage Project is assumed to be financed (as in the first two stages) by Government equity contributions and foreign loans. A foreign loan of US$100 million with 15-year terms including 3.5 years' grace is assumed for the Third Stage, which has an estimated cost of $300 million. Cash available from the Water or Dams Divisions is transferred as needed between these Divisions. About W 23 billion are to be

transferred from the Water to the Dams Division between 1984-87 to help finance the large dams program. In addition to this project, capital expenditures for equipment replacement are also included. Interest during construction is capitalized.

Balance Accounts

10. Accounts receivable, in accordance with present experience, are forecasted at 40 days of billing. Inventories are projected as a function of the annual material expenditures. Accounts payable are about one month of the capital expenditures.

B. Dams Division

Fixed Assets

11. The Dams Division operates three multipurpose dams (Andong, Soyang and Daecheong). Fixed assets incorporated by ISWACO include only water supply, power and 30% of the cost allocated to agriculture. The cost allocated to flood control is not included in the fixed assets, but the respective operational expenses are subsidized by the power and water revenues. Based on present estimates of cost allocations, 61% of the Chungju Dam, 70% of Hapcheon Dam and 79% of the Nagdong Barrage would be incorporated into the fixed assets. Average depreciation is estimated at 3% p.a.

Demand

12. Demand projections for the Dams Division were made during the appraisal. The main factor is the Chungju Dam, which would double the present power and water supply capacity. The Chungju Dam is expected to be completed on schedule by end 1985. The power generated by ISWACO replaces more expensive power generation using coal and oil. Therefore, the full power capacity is expected to be used as soon as it is completed.

Tariffs and Other Charges

13. Charges for power are based on kWh used (W 13.9/kWh in 1981). ISWACO has been discussing with KEPCO, and expects to increase these charges to W 18.4/kWh by end-1983. Under the proposed financial covenant (para. 5.09), these charges are expected to be increased to W 35.6 /kWh by 1986 (97% in real terms between 1982-86). Charges for water are based on the water used by municipalities or industries which expanded their capacity after the construction of ISWACO's regulating dams. Average charges are W 1.9/cu m (W 2.7 in the Nagdong River) which are expected to increase to W 3.1/cu m by 1986 (26% more in real terms). The water made available by the barrage is assumed billed at a price equal to the marginal cost. For financial projections this price is assumed at W 7/cu m in 1983 prices, which is the marginal cost at 9% discount. Irrigation charges are based on the number of irrigated hectares. Under past policies, no charges were levied on agricultural users, but now charges of W 20,880 per ha are being applied, and the number of hectares billed is assumed to increase from only 87 ha in 1982 to 25,000 ha by 1988.

Expenses

14. Expenses other than depreciation represent only 31% of the revenues of the Dams Division. The main expense is personnel, which accounts for 46% of the operating expenses before depreciation. The number of personnel is expected to increase 40% in real terms in 1986 (when the Chungju Dam enters into operation), and 20% more by 1988 with the operation of the Hapcheon Dam and the barrage. Power expenses to pump-back water during non-peak hours are estimated to increase by 15% in real terms between 1984-87. Materials are forecasted based on the new assets entering into operation.

Flow of Funds

15. The Dams Division forecasts large investments ($1,090 million between 1983-88 including $310 million in 1984) in three main projects: (a) the Chungju Dam, financed by OECF, the Bank and Government contributions; (b) the Nagdong Barrage financed by the Bank, sales of reclaimed land, internal cash contributions and Government grants, with the latter financing about 21% of the total project, corresponding to those investments to be recovered by the Government through established taxes (Annex 10, Table 3); and (c) the Hapcheon Dam to be financed by OECF ($100 million), Government grants and local loans. ISWACO's internal generation would finance about 19% of the total investment during the period 1983-88. This is remarkable, since ISWACO's capital expenditure in new dams during this period would be about three times the revalued net assets of the Dams Division. ISWACO is planning to build another 6 dams during the next ten years. However, no decision has been taken, financing plans have not been prepared and the feasibility studies are not complete. Therefore, the investments (other works) included in the financial projections are only tentative.

Balance

16. Accounts receivable are forecast at 10% of the amount billed. Other fixed assets include those assets which are not for rate of return calculation (agriculture, flood, etc). Contractor payables represent one month of annual capital expenditures.

KOREA

SECOND WATER SUPPLY PROJECT

Busan City Complementary Works

1. Water Supply Extensions. The city of Busan Water and Construction Bureaus will finance and build before December 31, 1987 (see also Table 1) a water supply extension scheme Stage I (500,000 CMD), which would provide water to 95% of Busan's population by 1987, comprising:

(a) a new water intake and pumping station at Maeri (3 km upstream of the present Mulgeum water intake) with an installed pumping capacity of 1,600 hp;

(b) one raw water pumping main, 2.2 m diameter and 6.5 km long, from Maeri to supply the new treatment plant at Deogsan on the west bank of the Nagdong River;

(c) the first stage (500,000 CMD) of the water treatment plant at Deogsan comprising conventional treatment facilities, ancillary building and staff quarters;

(d) the first stage (about 30 km) of primary distribution pipelines, of which about half are 2.2 m and the balance between 600 and 1,500 mm diameter;

(e) two booster pump stations with an installed pumping capacity of 4,800 hp and 9,400 hp at Sasang and Mandlek, respectively; and

(f) engineering and land acquisition to implement the above works.

2. Estimated costs of these works at 1983 prices are W 72 billion to be financed by OECF (W20.0 billion, 27.8%), internally generated funds (W 23.5 billion, 32.6%), MOC loans (W7.0 billion, 9.7%), and bonds (W 21.5 billion, 29.9%). Busan expects to complete these works by mid-1986. Secondary and tertiary distribution works for W 17,200 million (about 10 km) would also be executed during 1984-87, financed by internal contributions by Busan's WB and house connection charges.

3. Busan would also finance and build before December 31, 1987: the Jang Lim area sewer interceptor /1 which will intercept all sewage and

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/1 Busan City is also planning to build sewerage and sewage and industrial wastes treatment schemes to serve all the major city-developed catchment areas. Work is ongoing on the construction of the Yongho Treatment Plant to serve the main city central and harbor areas, and the Sayoung sewerage scheme which includes a sewage treatment plant to control pollution of the main bay (expected to be completed by 1986).

industrial wastes presently being discharged into the Nagdong river from Hwamyoung in the north to Jang Lim in the south, including the major Sasang Industrial Complex. This includes 15.5 km of interceptor sewer and box culvert and lift pump stations. Minor modifications necessary to existing storm water pumping stations will also be incorporated in these works. These works form part of the Busan City Master Plan. Detailed engineering will be completed by June 1984 and construction started in 1984 for completion in 1987. Estimated costs of the above works at 1983 prices are W 12.5 billion ($16 million) to be financed 20% by City funds, 60% by foreign and commercial loans and bonds and 20% by Government.

4. The City is also planning to complete the sewage treatment plant at Jang Lim at a cost of W 20.5 billion (at 1983 prices) as part of its pollution abatement activities. These outfall treatment works are being designed to meet OOE effluent quality standards of 40 ppm BOD and 30 ppm suspended solids and comprise primary and secondary treatment and sludge digestion facilities to treat 76,000 CMD of domestic and industrial wastes from a 50 sq km catchment area bordering the Nagdong river.

ANNEX 12
Table 1

KOREA

SECOND WATER SUPPLY PROJECT

Busan City Complementary Works
(Won million, 1983 prices)

	Year					Total cost
	1983	1984	1985	1986	1987	Stage I
Water Supply Extension Stage I						
Intake & Pumping Station Site preparation Intake 2 sand basins Pump station 2-800 hp pumps Living quarters	100	2,300	3,400	-	-	5,800
Raw Water Transmission 6.5 km 2.2 m Ø steel	4,600	4,500	-	-	-	9,100
Treatment Plant Site preparation 8 filter units 32 settling basins 4 clear wells Control buildings Electrical/mechanical equipment Living quarters	-	2,200	8,500	-	-	10,700
Primary Distribution 31 km 2.2 m Ø to 600 mm Ø Aqueduct 1.5 km 2 booster P.S.	-	13,000	22,000	7,800	-	42,800
Land Acquisition Compensation, Tax, etc.	2,300	450	350	-	-	3,100
Engineering	-	250	250	-	-	500
Subtotal	7,000	22,700	34,500	7,800	-	72,000
Secondary and tertiary distribution	-	7,800	7,800	1,600	-	17,200
Jang Lim Interceptor Sewer & Lift Stations 10.5 km pipesewer, 800 mm to 200 mm 5.0 km box culvert 2.1 m X 2.7 m Lift pump stations	-	2,500	5,000	2,500	2,500	12,500/a
Total	7,000	25,200	47,300	18,100	4,100	101,700
Total (US$ million)						130.4

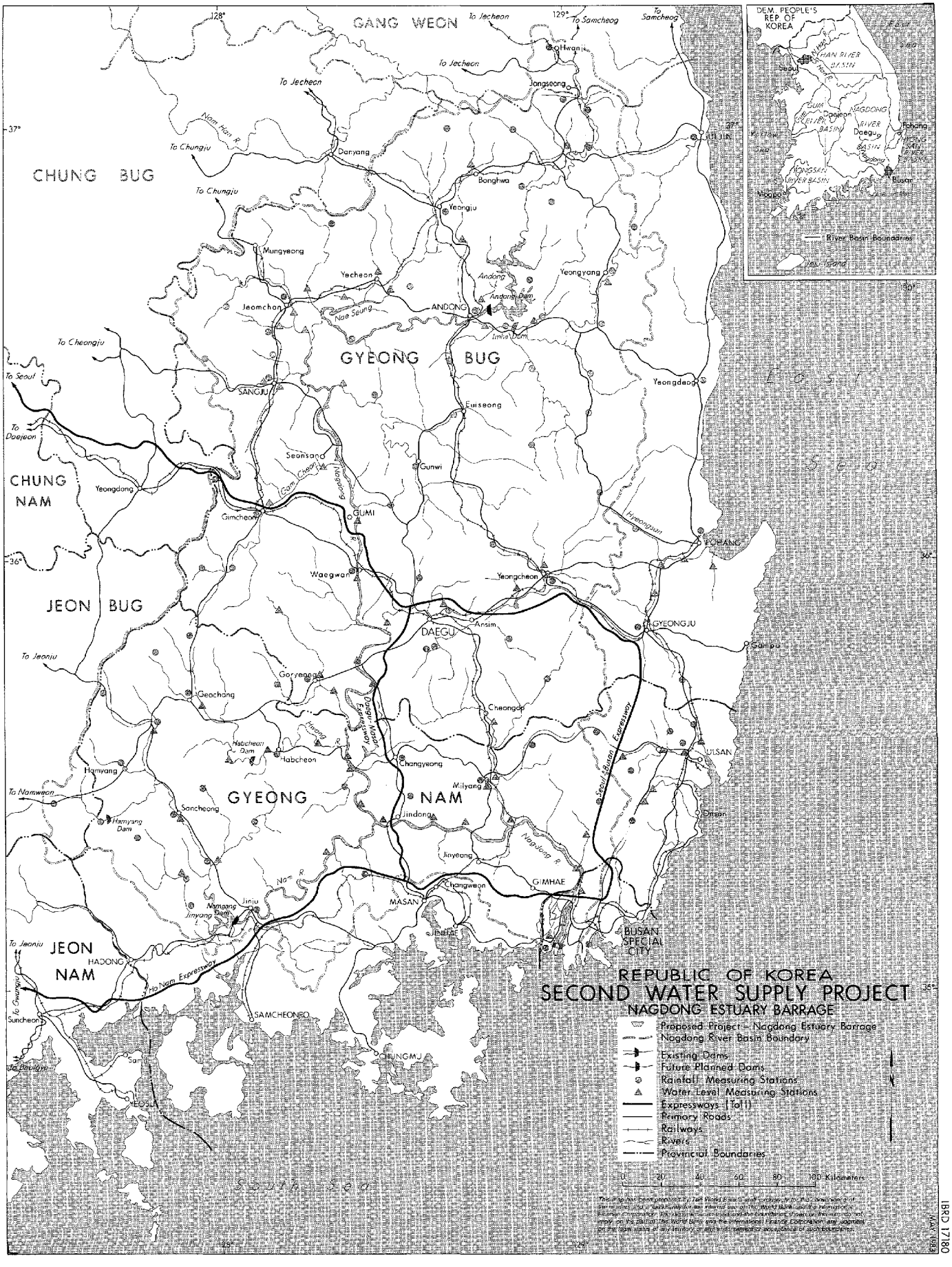
ANNEX 13

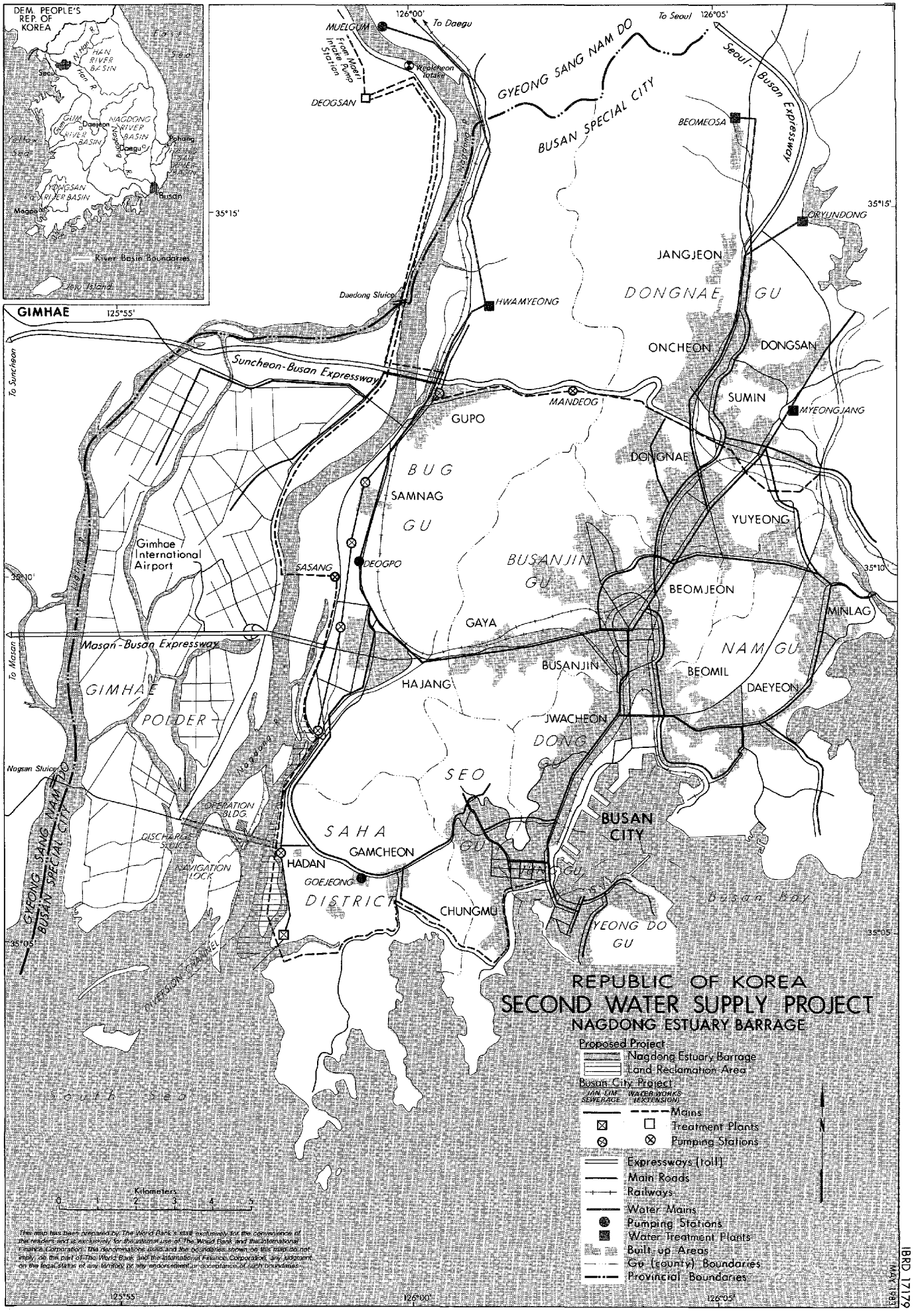
KOREA

SECOND WATER SUPPLY PROJECT

Selected Documents and Data Available in Project File

1. NEDECO, Interim Report on the Nagdong Project (December 1981)
2. NEDECO, Final Report on the Nagdong Estuary Barrage (May 1982)
3. NEDECO, Nagdong Estuary Barrage Project (update May 1983)
4. NEDECO, Nagdong Estuary Barrage and Reclamation Project - Environmental Programme (May 1983)
5. Nihon Suido-KECC, Third Stage Metropolitan Water Supply Project - Feasibility Report and Projections (June 1983)
6. Sector Study on Water Supply and Sanitation - WHO (1981)
7. Office of Environment, Environmental Conservation in Korea (December 1982)
8. ISWACO, Audit Statements (1981-1982)
9. ISWACO, Articles of Incorporation (1981)
10. Appraisal Projections for ISWACO's Water and Dams Division
11. Busan City Water and Sewerage Works and Financial Projections
12. Appraisal Mission Working Papers
13. Hapcheon Dam Project - OECF Appraisal Questionnaire
14. ISWACO, Prequalification Questionnaire and Evaluations
15. Korea's Environmental Preservation Law
16. Nagdong Barrage bidding documents, bid evaluation and award recommendation


GANG WEON
CHUNG BUG
CHUNG NAM
JEON BUG
JEON NAM
GYEONG BUG
GYEONG NAM
To Jecheon
To Samcheog
To Chungju
To Cheongju
To Seoul
To Daejeon
To Jeonju
To Namweon
To Jeonju
To Boulgye
To Gwangju
Nam Han R.
Nae Seung
Andong Dam
Imhie Dam
Gam Cheon
Nakdong R.
Hyeongsan
Hwang R.
Habcheon Dam
Hamyang Dam
Namgang Dam
Jinyang
Nam R.
Nagdong R.
Ha Nam Expressway
Seoul-Busan Expressway
Yeongdong Expressway
Ohwan
Jongseong
Daryang
Bonghwa
Yeongju
Mungyeong
Yecheon
Andong
Yeongyang
Jeomchon
ANDONG
Yeongdaeg
Euiseong
SANGJU
Seonsang
Gunwi
Yeongdong
Gimcheon
GUMI
Waegwan
Yeongcheon
POHANG
DAEGU
Ansim
GYEONGJU
Gampo
Goryeong
Geochang
Cheongdo
Habcheon
Changyeong
Hamyang
Sancheong
Jindong
Milyang
ULSAN
Onsan
Jinyeong
GIMHAE
Changwon
MASAN
Jinju
JINHAE
BUSAN SPECIAL CITY
HADONG
Suncheon
SAMCHEONPO
CHUNGMJ
Sam
Yosu
SOUTH SEA
EAST SEA
LOST
DEM. PEOPLE'S REP. OF KOREA
HAN RIVER BASIN
Seoul
NAKDONG RIVER BASIN
Daegu
Pohang
Busan
Masan
River Basin Boundaries
Jeju Island
REPUBLIC OF KOREA
SECOND WATER SUPPLY PROJECT
NAGDONG ESTUARY BARRAGE
Proposed Project - Nagdong Estuary Barrage
Nagdong River Basin Boundary
Existing Dams
Future Planned Dams
Rainfall Measuring Stations
Water Level Measuring Stations
Expressways (Toll)
Primary Roads
Railways
Rivers
Provincial Boundaries
0 20 40 60 80 100 Kilometers
IBRD 17180
MAY 1983


DEM. PEOPLE'S REP. OF KOREA
HAN RIVER BASIN
NAKDONG RIVER BASIN
GUM GANG RIVER BASIN
YONGSAN RIVER BASIN
SEOMJIN RIVER BASIN
Seoul
Busan
Daejeon
Daegu
Pohang
Mokpo
Yellow Sea
East Sea
River Basin Boundaries
Jeju Island
MUELGUM
To Daegu
From Main Pump Intake Station
Wooleheon Intake
DEOGSAN
GYEONG SANG NAM DO
To Seoul
126°00'
126°05'
BUSAN SPECIAL CITY
Seoul - Busan Expressway
BEOMEOSA
35°15'
ORYUNDONG
JANGJEON
DONGNAE GU
HWAMYEONG
Daedong Sluice
GIMHAE
125°55'
Suncheon-Busan Expressway
To Suncheon
ONCHEON
DONGSAN
MANDEOG
SUMIN
MYEONGJANG
GUPO
DONGNAE
BUG
SAMNAG
GU
YUYEONG
Gimhae International Airport
SASANG
DEOGPO
BUSANJIN GU
35°10'
BEOMJEON
MINLAG
GAYA
Masan-Busan Expressway
To Masan
NAM GU
BUSANJIN
BEOMIL
DAEYEON
HAJANG
GIMHAE POLDER
JWACHEON
DONG
SEO
Nagsan Sluice
OPERATION BLDG.
DISCHARGE SLUICE
NAVIGATION LOCK
SAHA
GU
BUSAN CITY
GAMCHEON
HADAN
GOEJEONG
DISTRICT
CHUNGMU
YEONG DO GU
Busan Bay
35°05'
GYEONG SANG NAM DO
BUSAN SPECIAL CITY
RIVERSION CHANNEL
South Sea
REPUBLIC OF KOREA
SECOND WATER SUPPLY PROJECT
NAGDONG ESTUARY BARRAGE
Proposed Project
Nagdong Estuary Barrage
Land Reclamation Area
Busan City Project
(JAN LIM SEWERAGE)
(WATER WORKS EXTENSION)
Mains
Treatment Plants
Pumping Stations
Expressways (toll)
Main Roads
Railways
Water Mains
Pumping Stations
Water Treatment Plants
Built-up Areas
Gu (county) Boundaries
Provincial Boundaries
Kilometers
0 1 2 3 4 5
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MAY 1983

KOREA

SECOND WATER SUPPLY PROJECT
NAGDONG ESTUARY BARRAGE